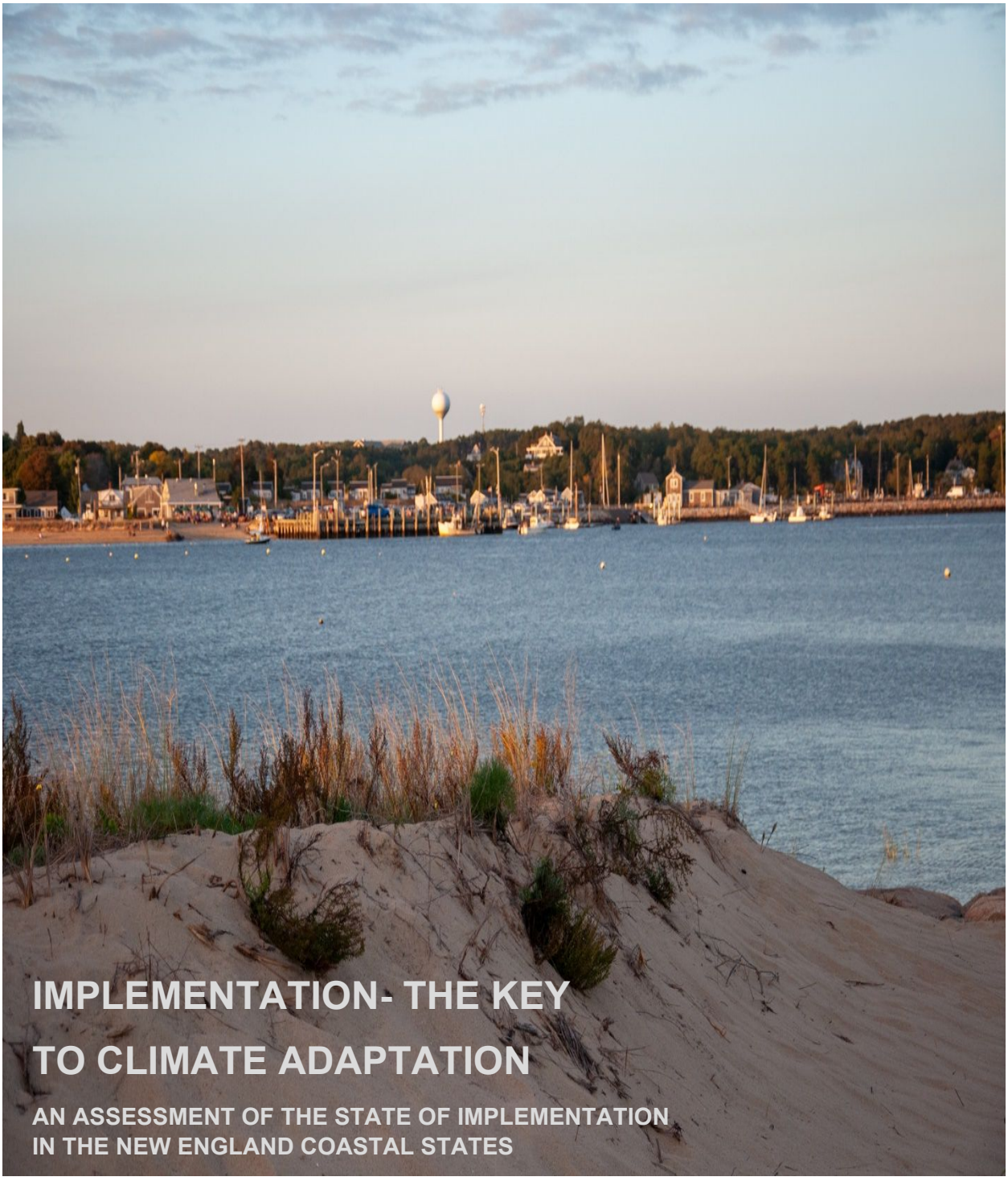

David Pomerantz, Sea Change Associates

ABOUT THE AUTHOR

As the Owner of Sea Change Associates **David Pomerantz** assists clients with implementing climate adaptation initiatives to enhance resilience in the built, natural and social environments. Through research and writing, technical assistance, facilitation and education, program assessment, capacity building and problem-solving David works with public, private and non-profit entities to accelerate climate adaptation implementation. His goal is to help advance adaptation to address flooding related impacts in coastal and inland regions.

David's education and professional backgrounds cover city planning, public administration, emergency operations, climate adaptation and construction management. He has a Bachelor of Community Planning degree from the University of Cincinnati, is a certified mediator and obtained a Climate Resilience Certificate for Professionals from the Center for Climate Preparedness and Community Resilience at Antioch University. He is retired from the fire service and has worked as a FEMA Disaster Reservist on numerous natural disasters. David is the Director of Facilities Management for the City of Northampton, MA. His work there covers hazard mitigation and emergency management, adaptation and sustainability planning, and procurement and construction administration for city projects. He plans to transition from his current role and focus his efforts with Sea Change Associates.

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ON THE COVER

Wellfleet Harbor, Wellfleet, MA.

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EXECUTIVE SUMMARY

Municipal managers confront a host of concerns on a daily basis, and increasing climate change impacts, including those from flooding caused activities, can exacerbate the challenges they face. Officials continuously deal with numerous competing demands for limited financial resources. There are increasing federal and state directives that need to be met which can result in unfunded mandates for municipalities. On top of that, incomplete and/or unclear information and projections concerning potential future climate change stressors and impacts can cause uncertainty and make it difficult to engage in decision making for climate adaptation programs and investments.

Awareness and understanding of financing options along with being able to calculate future avoided costs and positive community benefits from implementing adaptation measures is crucial for local officials. Understanding historic and potential social, economic and operational costs of climate change impacts can help in the delivery of essential services and with maintaining community health. Such information can assist in determining community risk taking based on current and projected climate impacts, can help in calculating if adaptation efforts should be short or long-term focused, or whether climate adaptation programs can lead to ancillary benefits for the community.

Continued sea level rise, land subsidence, tidal flooding, increased precipitation from more frequent and stronger events, storm surges and changes in ocean currents certainly will continue to generate increased flooding activity for coastal communities. To varying degrees this will lead to damaged or destroyed buildings, disruptions in the delivery of essential services, loss of tax revenue, decreased budgets due to ongoing rebuilding costs and the need to spend resources on emergency management, erosion, varying socio-economic impacts, and the potential for mandatory buyouts and retreat.

As coastal communities are being buffeted more and more by flooding impacts a growing number of towns and cities are engaging in adaptation vulnerability assessments and planning. With the development of recommendations and action steps in the planning phase decision making and the implementation of adaptation measures and programs would follow, which can result in increased resilience and decreased impacts.

This project focused on assessing how adaptation implementation is occurring and what the catalysts and impediments are for advancing implementation efforts to address flooding. The project focused on the five New England coastal states. Through research, a survey and numerous interviews, trends, issues and needs were identified that are shaping the status of adaptation implementation post vulnerability assessments and planning. Participants for both the survey and interviews included:

- Municipal officials (managers, planners, DPW, facilities).
- Regional planning commissions.
- Academic institutions.

- State agencies.
- NGOs.

Some of the key parameters that were used to structure the survey and conduct the interviews included:

- What is the key information local officials want or need in order to implement adaptation programs?
- Is such information, and analyses that should be conducted, different from what's needed to make other informed policy and program decisions?
- Are communities looking at adaptation efforts as part of holistic community development and operations or as separate mechanisms?
- What are the key identified or perceived catalysts and impediments affecting adaptation efforts?

The successful implementation of flooding directed adaptation measures can lead to increased resiliency, can reduce future damage and rebuilding costs, can generate wider community benefits, and can provide clear examples to other municipalities that there are means and methods to address climate change impacts.

The research, survey and interview components of the project examined how the following topics act as catalysts or impediments for the development and implementation of adaptation measures:

- **Financing**
- **Governance**
- **Design and permitting**
- **Coordination concerns and relationships between actors**
- **Modeling and cost analysis**
- **Decision making and attitudes**
- **Retreat**

Based on the information collected, the majority of climate adaptation work is still focusing on vulnerability assessments and planning. Planning efforts include the development of recommendation and action steps, as well as regulatory efforts covering hazard mitigation, emergency management and master planning. Vulnerability assessments coupled with flooding history are leading to programs to address municipal infrastructure where the focus is on storm water and wastewater systems. Adaptation efforts are including the development of green projects.

Among adaptation initiatives covering protection, accommodation and retreat, the majority of work is centered on protection (erosion and storm surge control and green infrastructure). A smaller degree of work addressing accommodation (elevating buildings, installing pump stations, roads) is occurring. Some communities are thinking about retreat, and it is being studied in places, but for most it is considered a future, last resort step.

Financing is a key concern. The availability and type of funding drives how decisions are made and the form and scale of projects that are initiated. Communities are utilizing their

operations and maintenance budgets, capital planning programs and state and federal resilience grants for adaptation work.

Communities need information on possible funding options that extend beyond grants and standard bonding including public-private partnerships, state revolving funds and green banks as examples. This can be accomplished with education and technical assistance. Financing is a touchy subject for many communities in that officials and the public can be reluctant to incur debt. Education and technical assistance can help show how spending funds on adaptation initiatives can lead to reduced rebuilding costs as well as ancillary community benefits.

Concerning governance and the ability to integrate adaptation efforts municipal operations, respondents said that coordination among departments is key for successful efforts. Along with coordination, staff expertise and time availability, as well as a lack of staff capacity in general, were noted as hurdles for advancing adaptation. Increased capacity building and coordination, not only among municipal operations but among regional, state and federal agencies, consultants, NGOs and academic institutions, was stressed as being critical for boosting efforts. For smaller communities with limited staff capacity, technical assistance with program coordination and project management could be provided by regional planning commissions or COGs in the form of circuit rider initiatives. Such efforts could also be beneficial to communities with grant writing.

Better coordination can also reduce time frames for work to be completed and reduce the cost of initiatives. Coordination issues within municipalities as well as between localities, state, federal and regional entities, and the private sector, was identified as being of concern. Similar to capacity building, regional or state resources could provide technical with program development and management assistance especially for coastal flooding projects that are multi-town or regional in scope.

Respondents also noted the need to address permitting and design issues, and that some of those solutions can be derived through better coordination among agencies. Other design and permitting concerns that were raised covered using standard versus custom designs for infrastructure, divergent permitting requirements among state and federal agencies and permitting and design time frames. This issue was raised enough times that it should be examined through assessments with the multiple actors involved.

Respondents noted the value in conducting cost-benefit assessments, in using modeling for prioritizing adaptation options and for calculating the social and economic benefits of adaptation initiatives. However, a lack of in-house capacity or assumed costs was identified as reasons for not initiating such work at the local level. That said, communities are conducting such work with efforts including: comparing adaptation options versus not doing anything, determining the ancillary benefits of adaptation measures such as raising roads, or modeling the potential failure rates for infrastructure based on storm surge and rainfall scenarios. Modeling and cost assessments are key tools that would help communities with adaptation planning and decision making, and could also be utilized to examine more regional focused projects. Education programs, technical assistance, pilot projects along

with working with private and academic institutions would be beneficial ways to help expand the understanding and use of modeling and cost-benefit assessment work.

This report is an initial step in an ongoing process to help advance adaptation efforts, and I've identified a number of important avenues to pursue with subsequent work using the information and findings here. The details generated with this work will be valuable to multiple professionals who are addressing flooding adaptation from different positions. The findings can help shape work with communities through pilot projects, and can be used to develop programs to export and transfer information to communities via education efforts. Also, there are needs for additional research that I'm planning to address.

INTRODUCTION

Municipal managers confront a host of concerns on a daily basis, and increasing climate change impacts can exacerbate those issues. Officials continuously deal with numerous competing demands for limited financial resources. There are increasing federal and state directives that need to be met which can result in unfunded mandates for municipalities. On top of that, incomplete and/or unclear information and projections concerning potential future climate change stressors and impacts can make it difficult to plan and prioritize programs and investments. And, a lack of information and understanding about innovative financing options for climate adaptation along with ways to calculate both future avoided costs and positive community benefits from implementing adaptation measures is crucial but not understood.

Being able to calculate a true understanding of historic and potential social, economic and operational costs of climate change impacts would help officials in delivering essential services and in maintaining community economic health. Along with affecting the provision of essential services climate events and impacts can result in:

- Lost business revenue, decreased property taxes and reduced property values from damaged or destroyed properties
- Extended sheltering and increased community stress
- Public health issues
- Lack of funds to rebuild as well as not having funds for other purposes
- Increased insurance rates and lower credit ratings
- etc.).

Local decision making for policy development and program implementation is shaped by political and community pressure, perceived or actual benefits and risks, available or assumed resources, and personal perspectives, to name a few.

Projecting climate change impacts covering increased temperatures, precipitation and flooding is an evolving science, and projection models are increasingly able to downscale

and focus information on more micro levels. However, estimating the resulting social and economic impacts from climate change, along with weighing options and monitoring the effects of implementing strategies and programs is difficult. Deciding what impacts to address under various time frames and levels of risk, along with what resources are or could be available, can increase confusion and uncertainty for municipal officials who continuously balance having to provide day-to-day essential services and plan for long term community stability and vitality.

With competing demands for the delivery of essential services, and the need to implement capital projects for infrastructure maintenance, school facilities, street lighting, hazard mitigation and emergency services, recreation facilities and economic development focusing on climate change adaptation efforts can feel daunting for municipal managers. For officials, there's the risk of an incorrect or inadequate commitment of resources due to uncertain projections or faulty decision making. Also, personal attitudes and political values can affect commitment and decision making. Political life spans can be different than investment schedules and implementation time frames and this can lead to a lack of support for projects.

Many communities examine potential financial expenditures based on estimated debt schedules and life cycle costing, and for the most part do not use modeling to look at the broader implications and potential community benefits of a project. Reasons for not using modeling can include a lack of in-house capacity to perform such analyses, possibly not understanding the benefits of such efforts, or a lack of funds to hire an outside consultant to conduct the work. Economic and fiscal modeling is slowly being used more and more in the area of sustainable development, and these tools could be very beneficial in relation to decision making and implementation of climate change adaptation initiatives.

The advent of more micro-level climate change projection data can provide clear information to assist with the development of adaptation plans. Modeling also can provide valuable information on adaptation costs and benefits for protecting the natural landscape and the built environment. Modeling can be used to calculate economic and social costs for previous climate impact events, and can assist with adaptation program implementation efforts by looking at future community costs and benefits based on climate change impact projections and assumptions as they change over time. Similarly, monetization models can provide valuable information on the costs and benefits of implementing various adaptation measures.

Along with economic modeling, monitoring and metrics is an area that has great potential to be expanded to assist communities with tracking and understanding the implementation of adaptation efforts. The intent should be to determine how and why efforts are working, to identify and understand where there are problems so changes can be made, and to make sure key information is being generated and used on a timely basis. As modeling, monitoring and metrics become more institutionalized with climate change adaptation work, the methods for and benefits of using such tools can be transferred to other communities.

Vulnerability assessments and adaptation planning are the critical first steps under the multi-step climate change planning process. Planning efforts can generate proposed strategies and action plans and can lead to increased stakeholder involvement. Strategies and action plans can be integrated into regulatory and policy frameworks governed by master planning, hazard mitigation planning, zoning ordinances and building codes, as well as municipal budgets, capital planning, and economic development efforts.

Regardless of community size, scale, rural-urban or coastal-inland composition, or the types of climate change impacts that are affecting it, the following multi-step process can be utilized to guide adaptation efforts:

- **Vulnerability Assessments**: community wide vs. specific sector(s); types and scale of impacts; time frames for occurrence; damage and cost projections.
- **Planning:** development of action steps, strategies and time frames.
- **Decision Making:** how and when to implement; tie into existing policies, programs and regulatory frameworks; no cost to high cost efforts; financing mechanisms; levels and types of risks that can be addressed and tolerated.
- **Implementation:** resources needed; single vs. multi-prong efforts; phasing; risks addressed and avoided; single vs. multiple benefits; increased buy-in and political will.
- **Monitoring and Metrics:** adjust efforts as they work or not, or as risks change; determine the worth of doing something and expending resources due to what might happen; calculate individual vs. multiple-benefits and avoided costs.

As the scale and scope of climate change impacts increases there is a critical need to advance the implementation and monitoring components of adaptation work. Accelerating those phases of the adaptation process can be accomplished by addressing the following:

- **What is the key information local officials want or need to know in order to implement adaptation programs?**
- **Is the information they need for climate adaptation efforts, and the analyses that should be conducted, different from what's needed to make other informed policy/program decisions?**

- **Are communities looking at climate change efforts as a gear in the holistic community operations and development machine, or is it viewed as a separate mechanism?**
- **What are some of the key current identified and/or perceived impediments for implementing climate change adaptation efforts?**
- **What are the essential and effective metrics being used to monitor adaptation measures to see what's working and to see if initial assumptions and decisions were correct?**

Continued sea level rise, land subsidence, tidal flooding, increased precipitation from more frequent and stronger events, storm surges and changes in ocean currents will continue to lead to increased flooding in coastal communities. The existence of climate change related flooding and the resulting diverse costs is now well documented, and flooding is perhaps the most visible climate change caused impact for communities. At this point, the significant physical, social and economic costs from flooding are acknowledged but may not be well understood even as they continue to increase. Even without a full understanding of climate change projections and costs the implementation of adaptation projects that address flooding can help coastal communities:

- Attain increased resiliency.
- Avoid future damage and rebuilding costs.
- Generate other community benefits.
- Provide clear examples to other communities that there are ways to address specific climate change impacts.

METHODOLOGY

With the intent to investigate the state of adaptation implementation for coastal related flooding impacts I employed the following methodology for this project:

GENERAL-

Coastal communities in the New England states (Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut) formed the geographic focus of the project. Collectively, there are 300 coastal zone communities with 6,130 miles of shoreline in the five coastal states.

To assess the state of adaptation implementation to address coastal related flooding information gathering and research was done via a literature review; the development and use of an online survey; and telephone interviews.

I used information compiled through this work to develop findings and generate conclusions about the state of flooding specific climate adaptation implementation. The findings and conclusions are presented in a final report.

LITERATURE REVIEW-

In this initial phase of work, I identified and summarized the state of implementation for climate change adaptation in general as well as for flooding related climate adaptation efforts occurring in New England coastal communities. I culled information from international and national climate change assessments, academic studies and state and municipal adaptation plans and reports.

The Fourth National Climate Assessment (NCA4), 2018, U.S. Global Change Research Program as well as the Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5), 2014, were reviewed to ascertain the state of climate adaptation implementation globally and nationally, as well as implementation in coastal areas.

In the literature search I also reviewed numerous municipal, regional, state, NGO and academic generated documents covering climate adaptation, flooding, vulnerability assessments, planning and implementation occurring in coastal areas of New England. Along with providing an in-depth look at adaptation efforts occurring throughout coastal communities and regions, these documents also provided the names of agencies, departments, organizations and staff engaged in adaptation work. I reached out to numerous organizations, agencies and departments, and was able to develop a large group of people to send the survey to and/or to request an interview.

ONLINE SURVEY AND INTERVIEWS-

To bolster the work conducted in the literature review I developed a 26-question survey that was sent to approximately 80 professionals in various organizations in the five New England coastal states. Along with the survey (the results of which are included in the Appendix) I interviewed 32 individuals engaged in climate adaptation who represent a wide array of organizations and institutions. The interviews and the survey were conducted to identify and examine implementation issues affecting flooding related adaptation efforts.

The following professionals and organizations were spoken with and/or surveyed:

- Non-profits engaged in coastal resilience work such as The Nature Conservancy and The Trustees of the Reservations.
- State agencies that offer technical assistance and grants such as the Massachusetts Dept. of Energy Resources Municipal Vulnerability Program and the New Hampshire Department of Environmental Services.
- Coastal municipalities who are working to address flooding related issues.
- Engineering and planning firms that work with local entities.
- Regional planning organizations.
- Academic institutions.

Based on my experience working on climate adaptation in a municipal setting, along with issues, drivers, impediments and concerns discussed and identified in the literature search, I structured the survey and interview questions to provide information on the following adaptation implementation related topics:

- Governance
- Financing
- Decision making and assessing options
- Attitudes and coordination
- Design and permitting

- Modeling and cost analysis
- Retreat

To explore these subjects in detail the survey and interview questions focused on the following:

- Methodologies, tools and drivers being used for implementation efforts as well as impediments, catalysts and needs for advancing implementation.
- How needed resources are identified and secured.
- How potential adaptation options are assessed and weighed, and how potential costs and benefits are calculated.
- The levels to which adaptation efforts are integrated into existing municipal operations efforts (comprehensive planning, capital planning, hazard mitigation, budgeting, etc.)
- How adaptation work addresses the issues of climate change uncertainty and time frames.
- Which adaptation measures are easier, harder, quicker or more long-term to implement.
- How stakeholder support is being engaged for decision making and implementation, and how a lack of stakeholder involvement can impact adaptation efforts.
- The types of information that is needed for decision making and implementation efforts.
- The degree to which and in what ways modeling and economic analyses are being used to determine the costs and benefits of implementing adaptation measures and for calculating the costs of climate change impacts.
- The extent to which flooding related relocation and retreat is an issue and how it is being addressed.

Additional details on the survey and interview mechanics and numbers are presented further in the final report.

FINAL REPORT-

Information collected via the literature search, the interviews and the survey were melded into a final report that presents findings and conclusions.

This document contains details on the following:

- A summary of the general state of implementation for climate change adaptation.
- A summary of implementation issues as it relates to flooding impacts throughout New England coastal zone communities.
- A summary of how and where flood related adaptation measures and programs are being developed and implemented in coastal communities.

- A summary of the benefits and issues communities are having with such efforts.
- Details on what communities say are the issues, tools, needs, information and resources that would be valuable in advancing flooding related adaptation efforts.

LITERATURE REVIEW-

THE STATE OF CLIMATE CHANGE ADAPTATION IMPLEMENTATION -

Implementation: to put into effect according to or by means

of a definite plan or procedure.

GENERAL OVERVIEW-

The field of climate change adaptation continues to evolve with much work still focusing on vulnerability assessments and planning. For coastal communities the majority of adaptation dealing with coastal hazards has dealt with erosion and flooding (1).

According to the Fourth National Climate Assessment (2018), adaptation implementation has increased but it not yet commonplace. The previous Third National Climate Assessment (2014) found that awareness, assessment and planning were underway but that there was limited implementation (2, 3). The focus of community efforts seems to be on actions that address current variability and extreme weather events rather than on actions that prepare for future change and threats (4).

Recent research has shown that while the level of implementation is increasing, there's less agreement and evidence regarding the consequences of such activity. Similarly, while it's understood that community acceptance is needed for implementation to proceed, it's not clear how that acceptance develops.

A plethora of studies have been conducted examining the adaptation process and what is required for climate change adaptation to be successful. The following are some of the elements that have been identified as incentives for planning and implementation:

- Catalytic elements such as disasters.
- External factors including legal requirements, engineering standards, climate financial risk disclosure.
- Community interest.
- Leadership and policy entrepreneurs.
- Outside funding.

Additional factors that shape or contribute to adaptation planning and implementation are:

- Plans that are written by professional staff and that are approved by local officials.
- Community engagement across jurisdictions and sectors, and public-private leaders who support the adaptation process.
- Adaptation actions that address multiple community goals, not just climate change.

- The identification of parties responsible for each step, explicit time lines and measurable goals.
- Adequate funding for actions and sustained community outreach and deliberation (5).

The existence of climate change adaptation strategies does not ensure implementation. How public and private actors and organizations are organized and the ways in which scientific information is used in bureaucracies are key for positive implementation efforts. Similarly, how choices are made, uncertainties are addressed and political support is built and sustained are necessary for successful implementation (6,7).

Uncertainty regarding the magnitude and time frames of climate change are large barriers to implementing adaptation programs. However, moving from planning to implementation via taking steps on a phased basis can address uncertainty issues. Phasing can also acknowledge time frame issues. In cases, measures and policies are implemented using no-regrets decisions which can generate immediate benefits and reduce the need for more long-term intensive and costly actions (8).

Adaptive capacity, which refers to the ability of a system to adjust to climate change, to moderate potential damages, to take advantage of opportunities, or to cope with consequences, can signal potential in an organization but does not guarantee that action will be taken (9). How well both planning and implementation happen is based on how regulations, policies and standards are created and enforced by governmental entities. Similarly, levels of participation by a wide array of stakeholders where cultural, social and political conditions are addressed, will affect how topics are viewed and how decisions are made.

Numerous barriers and drivers will affect the rate, comprehensiveness and success of adaptation planning and implementation efforts. Problem identification and framing, agenda setting, planning and strategy development, actual implementation and monitoring will all be affected as impediments and incentives change over time and interact with other issues (10).

Research conducted over time has shown that information, funding, addressing barriers and access to various tools are needed for successful community climate change adaptation planning, implementation and evaluation (11). Assessments have shown that knowledge of potential impacts and vulnerabilities doesn't necessarily lead to the most cost effective and efficient adaptation policy decisions. Communities that have implemented plans and strategies have mostly tended to adopt reactive and event driven approaches. As opposed to engaging in more full-scale implementation, technical measures are often meshed with existing policies which can lead to piecemeal and fragmented efforts.

The 2014 Climate Change IPCC report noted that at that time much less information existed on climate change adaptation implementation than on plans and strategies. The report stated that due to numerous uncertainties associated with climate change, as well as the complexities of social-ecological systems, that a variety of adaptation and implementation tools are required to address climate change (12).

To better address climate induced vulnerabilities through the identification and implementation of adaptation options integrated approaches are now being used for water resources management and coastal management. Integrated policies can meet multiple objectives covering climate change adaptation, land use development and disaster risk reduction. Integrated Coastal Zone Management, Community Based Adaptation, Disaster Risk Reduction and Ecosystem Based Adaptation are comprehensive planning models that are increasingly being utilized for climate change adaptation work.

Adaptation entails a continuing risk management process that has no end point. Integrating climate adaptation into existing organizational and sectoral policies and practices can provide both short-term and long-term benefits. Climate change planning and implementation should involve iterative risk management where ongoing assessment-action-reassessment-learning-response activities occur.

The 2018 National Climate Assessment- Reducing Risks Through Adaptation Actions noted that aspects of climate risk can be addressed and implementation efforts advanced through mainstreaming. With mainstreaming, adaptation efforts are integrated into existing organizational and sectoral investments, policies and practices including planning, budgeting, capital improvements, policy development, operations and maintenance. Mainstreaming of climate change adaptation is now occurring in financial risk reporting, business capital planning, engineering standards development, military planning and disaster risk management. Mainstreaming was noted as occurring in municipal operations by survey respondents.

A significant barrier to implementation is the fact that time scales for climate threats do not align with the time frames of governance. This schism can hinder adaptation progress and slow problem identification and action. Methodologies such as iterative risk management can provide a detailed framework and set of processes for advancing adaption. Iterative risk management encompasses the following:

- Steps for anticipating, identifying, evaluating and prioritizing current and future climate change risks.
- Steps for choosing an appropriate allocation of efforts and resources to reduce risks.
- Steps for monitoring and adjusting actions over time while continuing to assess
- evolving risks and vulnerabilities
  (13).

Continuing advancements in modeling for the generation of regional and local climate impact projections is allowing for more detailed adaptation planning and implementation efforts. The following are some of the modeling systems that are being used for climate impact projections as they relate to coastal communities, sea level rise and flooding:

- **Jupiter-** Predictive analytics of local weather and hydrological data that is combined with climate model projections. Assesses the impacts from sea level rise, heavier rainfall and storm surge activity to predict coastal flooding; https://jupiterintel.com/.
- **SLOSH (Sea, Lake and Overland Surge from Hurricanes) and ADCIRC-** Storm surge and hydrodynamic modeling that includes physical processes (winds, waves, freshwater discharge); https://slosh.nws.noaa.gov/slosh; https://adcirc.org.
- **Coastal Storm Modeling System (CoSMos)-** Integrates sea level rise, tides, seasonal effects, storm surge, waves and coastal change data. Predictions made via interactive web tools that include flood hazard maps and potential socio-economic exposure; https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos.

The large, urban coastal centers of Boston and New York City are employing modeling to examine complex systems as they identify interactions between sea level rise, storm surge, particular geographies of harbors and coastlines and at-risk infrastructure. As with all information collection and assessment the bottom line is to improve available information in order to make better calls.

Earlier modeling focused on long-term sea level rise with static tide levels but did not address tidal non-linearity, storms, short-term climate variability, erosion response, beach erosion and cliff retreat. As modeling continues to evolve, and additional parameters are added, more realistic information is being provided. At this point, additional model development is needed to assess uncertainty about risks and how that is addressed in adaptation planning and implementation (14).

Similarly, economic based models can be utilized to assess climate impact costs as well as identify the potential costs and benefits of various implementation strategies and measures. For example, monetization models can provide valuable information on costs and benefits for adaptation measures where different assumptions over time are used. Benefit analysis for adaptation options is an evolving field and more effort is needed to assess how to calculate the quantitative and qualitative aspects of different impacts and implementation options. Cost-benefit information does exist for adaptation measures related to storms, sea level rise and riverine and extreme precipitation flooding (15). Some organizations are combining multi-objective and multi-scenario approaches utilizing quantitative tools that can identify vulnerabilities as well as evaluate tradeoffs within different scenarios.

ADAPTATION IMPLEMENTATION IN COASTAL COMMUNITIES-

Per the 2014 IPCC Fifth Assessment Report: Impacts, Adaptation, Vulnerability- Coastal Systems and Low-Lying Areas there is high confidence that coastal areas will increasingly experience adverse impacts from sea level rise and storm surge activity which will cause flooding, erosion and socio-economic impacts to communities.

The IPCC 2014 assessment also noted that to address accelerating impacts more proactive responses can be made based on technological, policy, institutional and financial inputs, and that coastal adaptation efforts based on integrated coastal zone management, ecosystem protection and disaster reduction can be mainstreamed into management plans (16).

Coastal adaptation efforts are normally categorized as follows:

- **Protection-** Advance existing defense lines with land acquisition; beach nourishment; artificial dunes; seawalls-dikes-storm surge barriers; remove invasive or restore native plant species.
- **Accommodation-** Increased flexibility; flood proofing; flood resistant agriculture; flood hazard mapping; flood warning systems; replace armored defenses with living shorelines.
- **Retreat-** Allow wetlands to migrate inland; shoreline setbacks; managed realignment by breaching coastal defenses and allowing for intertidal habitat.

With visible escalation in sea level rise, marked increases in extreme precipitation events and advancements in more comprehensive modeling and local level projection tools, it needs to be determined if coastal specific adaptation efforts are advancing more rapidly than resilience programs for other impacts. Or, as discussed above, do implementation endeavors to address coastal climate change hazards face the same issues and impediments as besets adaptation initiatives for non-flooding impacts?

Continued sea level rise will lead to chronic inundation (storm-tidal flooding that occurs 26 times or more annually and covers more than 10% or more of a community's land area). Based on IPCC sea level rise estimates the following inundation estimates have been generated for U.S. coastal communities:

- By 2035, 170 coastal communities nationwide will reach or exceed the threshold for chronic inundation, and by 2060 270 coastal communities nationwide will be chronically inundated.
- By 2100, with moderate sea level rise, 490 communities across the country, including 40% of all East coast and Gulf communities, will be chronically inundated.
- With more rapid sea level rise 670 communities nationwide, and 60% of all East coast and Gulf communities, will experience chronic inundation. It's estimated that

30% of these communities will see three-quarters or more of their presently usable land area become limited for use.
- Approximately 300,000 homes and commercial properties with a current property value of $136 billion are at risk for flooding over the next 30 years.
- By 2100, 2.5 million residential-commercial properties valued at
- $1.07 trillion will be at risk for chronic flooding (17,18).

Significant flooding from storms and chronic inundation from tidal flooding can affect property values, tax revenue, the provision of services and overall community investments, and can lead to divergent perspectives on how much flooding is tolerable. What are the tipping points for taking action, and are there times beyond which for various reasons efforts are not worthwhile?

A community's safety and vitality depends on access to critical infrastructure and institutions. Sitting back and doing nothing or acting in incorrect ways can heighten coastal risks. Determining that certain adaptation measures are prohibitively costly can lead communities to spend money on mid-level measures that are ineffective and reduce funds for other efforts. Similarly, a lack of political will and resources along with continually rising seas can eliminate options.

Actions to address sea level rise, storms and related flooding can be based on using science-based projections and approaches that prioritize potential outcomes for decision making and assist with halting current policies that put people and property in harm's way (19). For communities that will face chronic inundation, resilience building, including changes to land use development policies and buyout and retreat options, should become top priorities.

Even with a commitment to address coastal hazards, community implementation efforts can be thwarted by any of the following:

- A lack of social and financial resources. This can include political will, insufficient budgets for the development of adaptation policies and the need to address other current pressing issues.
- Development projects that generate tax revenue but also create risks.
- State and federal catalysts and barriers (i.e. National Flood Insurance Program) and the regional vs. local scale and scope of climate change impacts.
- Credit agencies, insurers, banks.
- Polarized views in the community regarding the risk of sea level rise and extreme weather events and how critical the need is to address climate change.
- A lack of locally relevant data, along with gaps between useful climate information from scientists and the information needed by decision makers.

The 2014 Fifth Assessment Report from the IPCC highlighted the economic rationale and value in protecting the world's coastlines from coastal flood damage and land loss from sea level rise impacts (5- Coastal Systems and Low-Lying Areas). However, translating broad assessments into actionable, effective community efforts is difficult.

The IPCC report noted the need for further research covering the following topics:

- Valuation of coastal ecosystem services and adaptation costs and benefits that simultaneously consider the gradual impacts of land loss.
- Assessing adaptation options and strategies covering soft protection, accommodation and retreat and the tradeoffs between each.
- Governance for coastal adaptation and the role of institutions (20).

As sea level rise advances and more extreme precipitation events increase communities will need to determine who will pay for impacts and adaptation efforts and how that will occur, as well as assess if, how or when to relocate. Adaptation measures may be implemented that prevent inundation and more significant flooding but at large costs and may only be effective for a limited time.

Communities are raising streets and infrastructure and are installing additional pumping capacity for storm water to address flooding. While the National Flood Insurance Program, along with other federal programs, provides funds to rebuild, this can exacerbate problems by allowing reconstruction in areas that continue to flood. If adaptation costs for flooding impacts become unaffordable abandonment and retreat may be the only viable options. Retreat carries multiple social and economic costs. With reduced property tax revenues and lowered property values local government services can be eliminated and communities can deteriorate. Adding to municipal concerns about retreat is the fact that courts are ruling that governments that fail to protect private property must compensate owners for the value that is abandoned (21).

Since more vulnerable residents can live near lower lying coastal areas, and are frequently renters, questions arise about how this group's needs will be addressed if retreat becomes necessary. Flooding can affect all segments of communities with social, economic and environmental impacts with more vulnerable populations being impacted to a greater extent. Lower income residents frequently live in sections of towns close to industrial and commercial businesses where there can be environmental, economic and health issues in general and from specific flooding events. Beyond economic losses, flooding damage to businesses can cause environmental issues as well as damage to vulnerable resident's homes.

Many lower income residents rent so flooding can damage or destroy properties and if tenants don't have renter's insurance they may not be able to replace damaged possessions. Flood damaged roads and infrastructure can make it difficult to drive to access food, schools or work, or for there to be available public transportation. Flood damaged infrastructure can reduce the ability to provide emergency and other essential services to the general population including more vulnerable residents.

In interviews municipal officials discussed the need to help all residents of communities maintain self-identity, a sense of place and to preserve livelihoods. One town manager noted that plans are being developed for new housing to address eventual retreat for lower income residents who mostly work in town. The goal of the project is to help ensure that workers can remain in that community.

While entire communities can be vulnerable to flooding, certain population groups will be more vulnerable, especially if flooding continues to increase and intensify. Coastal officials interviewed for this project noted that key topics for discussions related to flooding damage and retreat center on who should pay for losses incurred, demands by residents that their properties be protected and access to them guaranteed, how many times properties should be rebuilt, how protocols and policies for keeping communities safe should be developed and how do current adaptation efforts relate to possible future required retreat. Disparate perspectives by stakeholders regarding the roles of individuals, businesses and governments in assuming the risks and benefits of living and working near the coast will shape how issues are looked at and how solutions evolve and are supported. This work will mold the scale, speed and effectiveness of adaptation implementation. At this point there is minimal focus on the investments, implementation actions and cost-dependent tradeoffs required to adapt (22).

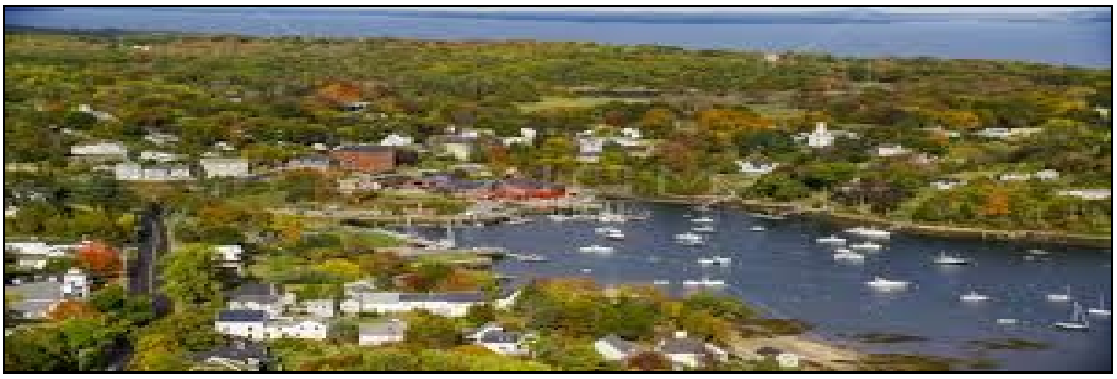
NEW ENGLAND STATE LEVEL ADAPTATION PROGRAMS- DRIVERS FOR COASTAL COMMUNITY EFFORTS-

Efforts at state levels concerning regulatory actions, funding and technical assistance certainly affect the scale and pace of adaptation work at the local level. In each of the five New England coastal states there appears to be ongoing evolution of existing planning, financing and regulatory efforts to assist regions and municipalities with adaptation efforts to address climate change impacts including flooding.

State agencies are engaging to coordinate and collaborate more amongst themselves which can reduce the "silo syndrome". Interviews conducted with state, regional and municipal officials, and with academic institutions and NGOs as part of this project, along with the results of a survey, reveal that there is a steady increase in adaptation implementation activities across the coastal states. Most efforts are focusing on projects to increase infrastructure resilience and regulatory activities through master planning and zoning to address floodplain related issues.

MAINE-

Maine has approximately 3,478 miles of coastline which increases to almost 5,000 miles when islands are included. Of the total state population of approximately 1.3 million about 720,000 (55%) reside in coastal portions of the state. Around 332,000 people are employed in coastal areas where they earn close to $14.5 billion annually. Those earnings equal about $34 billion in gross domestic product.



Through the efforts of groups such as the Maine Interagency Climate Adaptation Work Group (MICA) and the Maine Climate Council, the state is developing and administering programs to address hazard mitigation and climate adaptation for coastal areas covering the South Maine, Mid-Coast and Down East regions of the state. Professional groups such as the Maine Climate Change Adaptation Providers network (CCAP) serve an important

role in the development and implementation of adaptation programs and in helping to disseminate critical information about the evolving adaptation field.

Along with expanding traditional state agency planning, technical assistance and funding programs that help address flooding related coastal management, floodplain and infrastructure related issues, the state has developed climate adaptation tools including a Climate Clearinghouse and Maine Adaptation Toolkit to assist communities and businesses with adaptation planning. Various state agencies conduct ongoing research and analysis that results in the availability of critical information and data. Data collection and assessment covers coastal hazards, marsh migration and sea level rise, modeling the effects of sea level rise on transportation systems, and stormwater and wastewater system vulnerability assessments. There is a strong commitment and ongoing collaboration between state agencies, regional commissions and councils of government, local officials, NGOs and academic institutions to proactively address climate change and increase resilience.

Since 2012, the state Department of Agriculture, Conservation and Forestry has administered the Municipal Planning Assistance Program. In that time over $2 million in coastal community grants have been awarded for 74 projects across the state. Funds have been used to assist municipalities with vulnerability assessments, planning and design efforts covering a myriad of flooding related resilience projects. In many of the projects, partners have included academic institutions, land trusts, regional planning commissions and other environmental organizations.

Coastal community planning grants for FY 2021 include:

- **Town of Phippsburg/ Kennebec Estuary Land Trust: Collaboration to Increase Social Resilience in Mid-Coast Maine**
- **Town of Waldoboro: Septic System Vulnerability Analysis**
- **Southern Maine Planning and Development Commission: Developing A Model Coastal Resilience Ordinance to Protect Maine's Coastal Cities, Towns and Residents**
- **City of Gardiner: Downtown Master Plan - Reinforcing the City's Connection to Nature**
- **Southern Maine Planning and Development Commission: Development of Checklist and Technical Standards for Erosion and Sediment Control Plans for Municipal Separate Storm Sewer System (MS4) communities**

Additional resilience related grant and loan programs are administered by the state for: coastal resiliency planning, hazard mitigation planning, upgrading culvert systems and wastewater infrastructure projects to name several. As an example, the EPA Clean Water State Revolving Fund is utilized to simultaneously help with the development of wastewater facilities, address nonpoint sources of pollution, foster green infrastructure efforts and protect estuaries, all of which can increase community resilience.

The 2019 report by The Maine Interagency Climate Adaptation Workgroup (Maine Prepares for Climate Change- 2019 Update) reviewed state climate adaptation programs

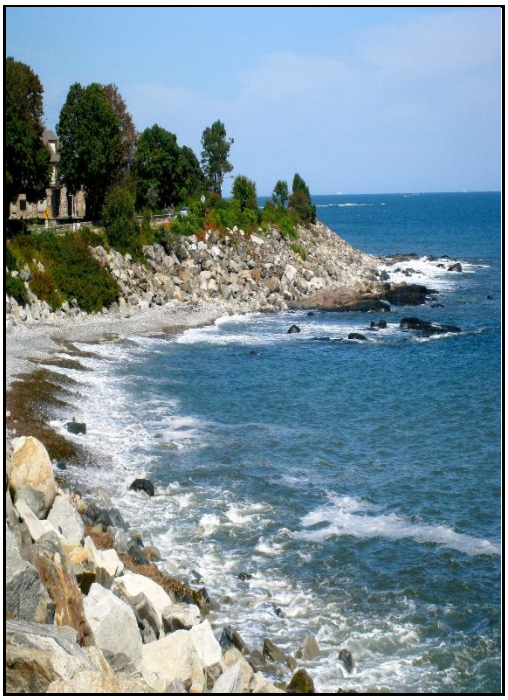
and efforts to date in relation to the initial 2010 state climate adaptation plan. The 2019 report presented details on programs and resources covering adaptation, preparedness and raising awareness, and identified grant and loan opportunities for community resilience planning and infrastructure construction.

Building on previous efforts, the Maine Climate Council is currently working on the development of multi-faced strategies that will allow the state to address climate adaptation at the state and local levels more efficiently and effectively.

NEW HAMPSHIRE-

At just over 18 miles, New Hampshire has the shortest ocean coastline of any of the U.S. coastal states. That figure increases to 235 miles when estuarine shoreline is calculated. Of the approximate 1.3 million people that live in New Hampshire roughly 425,000 (33%) reside in coastal portions of the state. About 190,000 people are employed in coastal areas of the state and they earn close to $9.8 billion annually. Those earnings equal about $23 billion in gross domestic product. Like the other New England coastal states, protection of natural resources along with ensuring community stability and economic growth is driving New Hampshire to address climate adaptation.

Through the New Hampshire Department of Environmental Services (NHDES) the state administers the 2009 Climate Action Plan which contains strategies and recommendations to address energy, environmental and economic issues in light of increasing climate change. The key focus of the climate action plan's 67 proposed actions is to: reduce carbon emissions; protect natural resources for both enhanced carbon sequestration and protection of the built environment; and take steps to adapt to climate change impacts. To move beyond planning into implementation, the state climate action plan called for legislative efforts to address regulatory issues covering building codes, zoning regulations and tax code issues, as well as the establishment of financial incentives and diverse funding mechanisms.



The New Hampshire Coastal Risk and Hazards Commission was created in 2013 by legislation to examine projected coastal flooding and to develop legislative and other recommendations for the state and municipalities to increase resilience. The group's final report, Preparing New Hampshire for Projected Storm Surge, Sea-Level Rise, and Extreme Precipitation, was released in 2016. Based on scientific information concerning climate change projections, as well as vulnerability assessments and impact related information compiled during the commission's work, the report presented multiple recommendations to address flooding related climate impacts by focusing on a framework called SAIL (science, assessment, implementation, legislation).

As the primary state agency coordinating state and federal mandated efforts covering air, water and waste, NHDES is the lead agency steering climate adaptation efforts. In conjunction with other state agencies, regional planning agencies, NGOs and academic institutions, the NHDES provides assistance to municipalities. Efforts include advancing the Climate Change Adaptation Toolkit, overseeing climate resilience efforts for drinking water and wastewater and administering the New Hampshire Coastal Zone Management program.

The state's coastal zone management program covers initiatives that address coastal restoration along with hazard mitigation and resilience, and includes oversight of the New Hampshire Coastal Resilience Grant program. Over the last six years, 16 projects in coastal communities have been awarded grant funds to pursue vulnerability assessments and planning work. During that time grantees were awarded about $700,000 in federal grants. Some of the work that has been completed in coastal communities using coastal resilience grants as well as pre-disaster mitigation funding from FEMA includes:

- Seabrook: Vulnerability Assessment Seabrook Wastewater Treatment Facility
- Rye: Master Plan- Coastal Hazards and Climate Adaptation
- Portsmouth: Climate Change Vulnerability Assessment and Adaptation Plan
- Exeter: Integration of Coastal Resilience in Sustainability Program Development
- Dover: Improved Stormwater and Urban Tree Management
- North Hampton: Development of Coastal Hazards and Adaptation Master Plan Chapters

With information contained in the recent New Hampshire Coastal Flood Risk Summary (2019), a multi-agency effort that presents current information on flood risk projections and guidance for using the information, coastal communities will be able to apply for resilience grants to address flooding related impacts.

To help coordinate and advance climate adaptation work in the state, the New Hampshire Coastal Adaptation Workgroup (NHCAW) provides assistance and education to communities. NHCAW, which is comprised of 24 organizations covering state, academic, NGO and private entities, helps coordinate research, planning and assessment work to advance resilience levels to address climate impacts.

MASSACHUSETTS-

The state has 192 miles of coastline (1,519 miles when tidal areas are included) that stretches from the New Hampshire to Rhode Island borders and includes Cape Cod, Martha's Vineyard and Nantucket. Approximately 76% of the total Massachusetts population of 6.7 million people live in coastal portions of the state. There are about 2.7 million people employed in the 78 municipalities located within the state coastal zone who earn $190 billion annually. Those wages equate to about $415 billion in gross domestic product.

State efforts to address climate change, including greenhouse gas emission reductions, were initiated with Executive Order 569 (Establishing an Integrated Climate Change Strategy for the Commonwealth) in 2016. The order called for state agencies to create a Climate Adaptation Plan and to initiate programs to increase state and local resilience. A climate adaptation plan was implemented in 2018 via the Statewide Hazard Mitigation and Climate Adaptation Plan. The plan updated and expanded the 2013 state Hazard Mitigation Plan by adding climate adaptation planning.

Using the framework in Executive Order 569, along with the Environmental Bond Bill (2018) which provided funding for projects that would increase resilience, the state has pushed climate adaptation planning and implementation efforts. The Municipal Vulnerability Preparedness grant program, which is administered by the Executive Office of Energy and Environmental Affairs, provides funds for municipalities to conduct vulnerability assessments and to develop action plans. The MVP program, which began in 2017, provides planning and action grants that allow communities to conduct education, planning and program development for adaptation initiatives to protect the built and natural environments. At this point, 82% of the Commonwealth's cities and towns are enrolled in the MVP program. To date, over $17 million in grants have been awarded for adaptation planning to about 250 communities across the state.

To build on initial efforts that grew out of Executive Order 569 the Governor signed legislation in 2018 (An Act Promoting Climate Change Adaptation, Environmental and Natural Resource Protection and Investment in Recreational Assets and Opportunity-H.4835). This legislation provided additional funding for state and local resilience programs:

- $290 million (bond program) to be used to fund improvements and repairs to dams and seawalls and to implement diverse coastal resiliency strategies.
- $75 million to provide planning and action grants to communities through the Municipal Vulnerability Preparedness (MVP) Program.
- $100 million to be invested in implementing the Commonwealth's Integrated State Hazard Mitigation and Climate Adaptation Plan.

The office of Coastal Zone Management, which is located within the Executive Office of Energy and Environmental Affairs, coordinates policy, planning and technical assistance concerning coastal issues, and implements efforts under the federal Coastal Zone Management Act. To that end, CZM administers the Storm Smart Coasts program and coordinates the Coastal Resilience Grants program. Since 2014, Coastal Resilience Grants, which can be up to $1 million per applicant with a 25% local match, totaling about $17 million have been made to approximately 127 municipalities and organizations. Grant funded work covers planning, public outreach, feasibility assessments, analysis of shoreline vulnerability, as well as project design, permitting and construction.

Some of the current efforts being funded by CZM include:

- **Chatham: Shoreline Erosion Reduction Alternatives**
- **Essex County: Coastal Resiliency- Education and Communication**
- **Hull: Wastewater Treatment Facility Nature Based Resiliency Measures**
- **Marblehead: Adaptation Strategies for the Town and Harbor**
- **Scituate: 50-Year Coastal Vision and Near-Term Adaptive Strategy Development**
- **Wareham: Final Design for Overflow Lagoon at the Water Pollution Control Facility**

To provide structure and advance adaptation efforts the Governor created the Resilient MA Action Team in 2019 (RMAT). Led by the Executive Office of Energy and Environmental Affairs and the Massachusetts Emergency Management Agency, and made up of multiple state agencies, RMAT will focus on the implementation of the combined hazard mitigation and climate adaption plan and work to advance resilience efforts.

As with other states, academic institutions, regional planning agencies, land trusts and environmental groups are working alongside state and local governments in Massachusetts to advance climate adaptation through existing regulatory and financing avenues as well as through the creation of new programs and mechanisms.

RHODE ISLAND-

The state's entire population of about 1.1 million people reside in coastal areas. The smallest of the U.S. states has 384 miles of coastline when tidal inlets are included. Rhode Island's coastal economy employs approximately 470,000 people who earn a total of $23.8 billion annually. These wages translate into $55.65 billion in gross domestic product for the state.

The Rhode Island state climate resilience action strategy, Resilient Rhody (2018), which contained 61 measures, guides climate adaptation initiatives and focuses on five key areas:

- Critical infrastructure and utilities
- Natural systems
- Emergency preparedness
- Community health and resilience

- Financing for the expansion of existing programs and the development of new initiatives to support implementation

The resilience plan notes the importance of preserving marshes and wetlands as well as the need to study possible retreat and infrastructure redesign and relocation. Providing communities with technical assistance and funding for the implementation of resilience initiatives is called for in the plan.

The development of the state climate resilience strategy evolved from the creation of the Rhode Island Executive Climate Change Coordinating Council (RIEC4) which was established in 2014. The Council is comprised of 12 state agencies and works to coordinate pertinent initiatives among state agencies and to develop resilience programs for regional and local application. Rhode Island state agencies are integrating climate adaptation efforts into existing regulatory and programmatic efforts through expansion of their work, and are developing new initiatives that will address the components of the Resilient Rhody plan.

The state Municipal Resilience Program is administered by the Rhode Island Infrastructure Bank which makes grants available to communities for climate resilience planning and implementation. The Rhode Island Infrastructure Bank, which was created in 1989, provides technical assistance and financing to municipalities, businesses and homeowners to undertake critical infrastructure projects covering water, storm water, wastewater, transportation, energy and resilience.

The following are examples of grants that have been awarded via funding from the 2018 Green Energy and Clean Water Bond program:

- **Barrington: Promote coastal resilience at Allin's Cove and Latham Park to restore and prevent future shoreline erosion allowing for salt marsh migration and preservation of public access to the park.**
- **Bristol County Water Authority: Promote the ecological resilience of the Kickemuit River system by removing the Upper and Lower Kickemuit River dams, increasing**

flood storage capacity of the wetland, and reducing flooding of low-lying roads during precipitation events and coastal storms.

- Coventry: Improve the Upper Dam Pond by reducing stormwater runoff from local roadways and the surrounding high-density residential neighborhoods and phosphorus loadings into the pond.
- Narragansett: Improve resilience at the Middlebridge Conservation Area through the removal of impermeable pavement and installation of salt-tolerant grasses, shrubs and other vegetation to create a park-like setting that will enhance the resilience of the site and accommodate sea-level rise in the coming decades.
- Newport: Eliminate dry-weather flooding associated with sea level rise and significantly minimize wet-weather flooding through the installation of tide gates and bar racks in the vicinity of Wellington Avenue.
- North Kingstown: Incorporate low-impact stormwater management with enhanced green infrastructure to adapt to changing coastal conditions and mitigate stormwater runoff and high tide flooding in the municipal parking lot in Wickford.

Along with the above projects, communities are working to increase resilience and address climate related flooding and associated costs through planning and capital efforts covering an array of projects including: pavement removal; storm water management; structure removal; natural feature restoration; road relocation; bank regrading and stabilization; culvert redesign; and utility removal or relocation.

The Coastal Resource Management Council (CRMC) works to meet its mandate to preserve and protect coastal areas via administering coastal management plans. Using tools such as the Coastal Hazard Application Worksheet and Viewer applicants for permits can understand flooding, sea level rise and storm surge concerns and work to address issues and risks. Through its programs the Coastal Resource Management Council works with communities to both guide and regulate development in the face of climate change flooding.

A key tool that CRMC utilizes to research coastal area changes and to provide assistance to municipalities is the Rhode Island Shoreline Change Special Area Management Plan (Beach SAMP). Assistance with Beach SAMP is provided by the University of Rhode Island Resources Center and Rhode Island Sea Grant.

CONNECTICUT-

Of the 3.6 million people that live in Connecticut 2.2 million of them live in coastal areas of the state. There are approximately 972,000 people employed in coastal areas who earn about $66 billion in wages annually. Connecticut has about 96 miles of coastline (618 miles with tidal areas included) that spans the Long Island Sound and Block Island Sound.

The Governor's Council on Climate Change (GC3), which was re-established and expanded in 2019 with the Governor's signing of Executive Order No.3, focuses on mitigation efforts to reduce greenhouse gas emissions as well as climate adaptation planning and implementation. Executive Order 3 increase the membership of the GC3 and expanded the

mandate of the GC3 with a call to develop a climate adaptation strategy that addresses infrastructure, agriculture, natural resources and public health. These efforts are to be incorporated into an updated state Adaptation and Resilience Plan for Connecticut which is to completed next year. The GC3 is comprised of 23 representatives from state agencies, businesses, local governments and non-profit organizations with the state Department of Energy and Environmental Protection coordinating the efforts of the group.

A previous initiative to assist municipalities with adaptation planning was the Municipal Resilience Planning Assistance Project. The program focused on helping communities to identify vulnerable infrastructure that could be impacted by river flooding, sea level rise and storm surges, and was administered by CIRCA, the Connecticut Institute for Reliance and Climate Adaptation. CIRCA, which is based at the University of Connecticut, assists coastal and inland floodplain municipalities advance climate adaptation and increase resilience. Funding for the previous grant program was through the State of Connecticut Department of Housing CDBG Disaster Recovery Program and HUD. Examples of community projects funded under this program included:

- **Westport: Downtown Flood Resilience- Master Drainage Plan and Stream Study**
- **Madison: Three-Town Coastal Resilience Plan**
- **Fairfield: Downtown Resilience Planning Using Green Infrastructure**
- **New Haven: Infrastructure Bulkhead Engineering and Design**
- **New London: Drainage Improvements**
- **Milford: Beach Resiliency and Stabilization**

CIRCA is now engaged in a multi-year adaptation planning project, Resilient Connecticut, covering Fairfield and New Haven Counties where planning frameworks and policy, planning and project initiatives will be developed by 2022. Resilient Connecticut will create a regional coastal resilience plan that will address natural ecosystems, critical infrastructure and economic activity.

To advance adaptation, CIRCA works with other organizations to conduct research, produce policy white papers and case studies, and to promote capacity building. For example, efforts

from the UConn Center for Energy and Environmental Law have addressed floodplain building elevation standards, height restrictions on elevated buildings and issues surrounding the statutory adoption of sea level rise scenarios.

FINDINGS-

SURVEY AND INTERVIEWS

A survey was developed to examine adaptation implementation for flooding impacts occurring in New England coastal communities. A 26-question survey was emailed to 76 potential respondents in Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut. Contacts included:

- State agencies involved with coastal management, environmental protection and climate adaptation.
- Regional entities including planning agencies and commissions, and economic development organizations.
- NGOs including land trusts, greenbelt associations, estuary alliances, and other environmental groups.
- Municipalities.
- Academic institutions.
- Engineering firms involved with infrastructure design.

The survey was also linked online to several state professional adaptation groups.

Along with the survey, 32 individuals working throughout the five New England coastal states were interviewed. The interview pool was comprised of the following:

- State agencies (coastal management, environmental protection, governor's office).
- Regional planning agencies and commissions.
- NGOs (land trusts, environmental groups).
- Academic institutions conducting adaptation and resilience work.
- Municipalities (town administrators/managers, municipal utilities, planning staff, public works, conservation agents, conservation commissions).

Not everyone who was interviewed completed a survey and vice versa.

SURVEY-

There was a six-week period to respond to the survey. Of the 76 surveys sent, 27 responses were received for a 35 percent response rate. The following is a breakout by group for the surveys sent and the responses received:

GROUP	SENT	RECEIVED
NGOs	11	2
Academic Institutions	7	2
Municipalities	37	17
State Agencies	9	4
Engineering-Planning Cos.	4	0
Regional Planning Comm.	8	2
TOTAL	**76**	**27**

The survey focused on the following adaptation implementation topics:

- **Implementation and municipal governance.**
- **Implementation tools and resources- information for decision making.**
- **Assessing implementation options.**
- **Funding mechanisms.**
- **What guides implementation- catalysts and impediments.**
- **Relationships between adaptation actors.**
- **Retreat.**

IMPLEMENTATION AND

MUNICIPAL GOVERNANCE-

Municipalities are advancing flooding adaptation specifically through planning and construction efforts, and on a broader scale by integrating adaptation within departments and coordinating activities among municipal functions. On the planning side hazard mitigation and emergency management (92%) and comprehensive land use planning (85%) are being focused on most extensively. Those efforts appear to be greater than upgrades being made to building codes (25%) and zoning ordinances (40%).

Concerning municipal infrastructure and critical facilities, upgrades to stormwater and wastewater systems, including green and hybrid infrastructure, are being implemented to protect systems and focus on increasing community flooding (74%). Municipal staff noted the need to address buildings and facilities that are experiencing flooding or are in areas that will be impacted based on flood projections. Respondents stated that adaptation work is being entwined with capital planning programs (62%). Along with capital planning, municipal budgeting is being used as a vehicle to undertake adaption implementation (41%).

Q2. Note where flooding related adaptation program (FRAP) measures and programs are being developed within the following existing municipal planning and operations structures.			
Responses	**Responses**	**%**	**Percentage of total respondents**
Hazard Mitigation- Municipal Vulnerability Planning- Emergency Management	27	93.10%	
Comprehensive long-range land use planning and/or sustainability planning	24	82.76%	
Building codes	8	27.59%	
Zoning ordinances	11	37.93%	
Storm water and Waste water infrastructure	21	72.41%	
Capital planning	18	62.07%	
Municipal budgeting for operations and maintenance	11	37.93%	
Sectoral plans (spatial development; transportation; housing; economic development)	8	27.59%	
Other	3	10.34%	
(Did not answer)	0	0%	
Total Responses	**131**		20% 40% 60% 80% 100%

Diverse modeling structures and frameworks exist to assist with flooding related adaptation planning and implementation. Some are more general risk management based while others are issue based (i.e. integrated coastal zone management, disaster risk reduction). In the survey respondents noted using economic cost-benefit analysis (52%), community-based adaptation (51%) and disaster risk reduction (48%) tools to assist with their adaptation work.

Q7. Various frameworks and modeling systems exist to assist with flooding related adaptation planning and implementation. Note which of the following you have utilized.			
Responses	**Responses**	**%**	**Percentage of total respondents**
Iterative risk management	5	17.24%	
Economic cost-benefit analysis including return on investments, life spans, ancillary benefits	15	51.72%	
Monetization assessments	4	13.79%	
Community Based Adaptation	14	48.28%	
Robust Decision Making	7	24.14%	
Integrated Coastal Zone Management	12	41.38%	
Adaptive Management	11	37.93%	
Disaster Risk Reduction	13	44.83%	
Other (Please specify)	3	10.34%	
(Did not answer)	3	10.34%	
Total Responses	**87**		20% 40% 60% 80% 100%

Establishing an adaptation focused fabric throughout municipal government can highlight issues, keep adaptation in the forefront and increase coordination and success levels. Municipal respondents noted that climate adaptation work is being integrated across sectors and coordinated by a dedicated team (44%). On the other hand, half those responding noted that planning and implementation proceeds in a limited and isolated fashion (55%). This pass of the survey did not provide details on the depth and breadth of how adaptation is being integrated into municipal operations. However, respondents did say that integrating adaptation implementation efforts into municipal governance has led to more successful efforts over a shorter period of time (63%).

Q10. How has adaptation planning for FRAP been mainstreamed into established functions of local government operations?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Across sectors coordinated by a dedicated team with community wide adaptation strategies	12	41.38%	
Planning and action proceed in a limited and isolated fashion	16	55.17%	
No internal responsibility assigned for planning and implementation with a reliance on external resources	7	24.14%	
Other (Please specify)	4	13.79%	
(Did not answer)	1	3.45%	
Total Responses	**40**		20% 40% 60% 80% 100%

Q11. If adaptation and implementation efforts have been integrated into municipal governance has this led to more successful efforts over shorter time frames?			
Responses	**Responses**	**%**	**Percentage of total respondents**
More successful efforts	18	62.07%	
Shorter time frames	5	17.24%	
(Did not answer)	10	34.48%	
Total Responses	**33**		20% 40% 60% 80% 100%

Regardless of the frameworks used for adaptation planning and implementation, or the levels to which adaptation work is integrated into municipal operations, those responding to the survey and in interviews noted that the following is critical for adaptation efforts: stakeholder buy-in (69%); comprehensive, accurate and micro-level flood projection data (67%); economic information concerning the cost-benefit analysis of projects (76%); and identified funding options (89%).

Q1. What are the key things local officials need or want to know in order to implement flooding related adaptation programs (FRAP)? NOTE- "FRAP" is used throughout the survey and denotes Flooding Related Adaptation Programs.			
Responses	**Responses**	**%**	**Percentage of total respondents**
Stakeholder buy-in	20	68.97%	
Flood projection data	19	65.52%	
Economic information covering the impacts of flooding damage over	20	68.97%	

time (including historical and potential future events)			
Economic information from cost-benefit analyses on possible ancillary benefits, avoided costs and return on investment for measures being considered	22	75.86%	
A track record of previous steps and accomplishments	5	17.24%	
Funding options identified	26	89.66%	
(Did not answer)	0	0%	
Total Responses	**112**		20% 40% 60% 80% 100%

IMPLEMENTATION TOOLS AND RESOURCES- INFORMATION FOR DECISION MAKING-

Both in the survey and through interviews respondents were asked to discuss the types of data that are used to understand flooding impact issues and to make implementation decisions. As the adaptation field evolves data, modeling and projections are becoming more comprehensive and micro-level based. Federal, state, non-profit and corporate work is leading to more and more tools for understanding flooding potential and its costs, and for calculating the costs and benefits of options.

As the graph below shows some of the more common resources used by officials for understanding and planning for flooding include:

- NOAA- U.S. Climate Resilience Toolkit: Sea Level Rise and Coastal Land Use (48%).
- NOAA- Office for Coastal Management: Digital Coast (33%).
- NOAA- Sea, Lake and Overland Surges from Hurricanes (SLOSH)- (33%).
- FEMA- HAZUS Mitigation Planning (44%).

Along with the governmental, non-profit, academic and private resources listed in the survey, respondents also noted the presence and use of the following state specific tools:

- Maine: geological data and Climate Change Adaptation Toolkit.
- Rhode Island: shoreline change maps and STORMTOOLS.
- Massachusetts: Coastal Flood Threat and Inundation Mapping viewer.
- New Hampshire: state-based flooding assessment conducted in conjunction with UNH.

Q19. Which of the following tools and resources are used for flooding related adaptation planning and implementation?			
Responses	**Responses**	**%**	**Percentage of total respondents**
U.S. Global Change Research Program- National Climate Assessments	3	10.34%	
NOAA- U.S. Climate Resilience Toolkit: Sea Level Rise and Coastal Land Use	14	48.28%	
NOAA- Adaptation Clearinghouse	5	17.24%	
NOAA- Office for Coastal Management: Digital Coast	9	31.03%	
Climate Central- Surging Seas	2	6.90%	
Georgetown Climate Center- Adaptation Clearinghouse	5	17.24%	
First Street Foundation- National Flood Model	4	13.79%	
Cape Cod Commission- Coastal Planner	3	10.34%	
Jupiter Intelligence- Modeling for Climate Change Risk	0	0%	
NOAA- Sea, Lake and Overland Surges from Hurricanes (SLOSH) Model	10	34.48%	
ADCIRC- Model for Predicting Storm Surges and Tides	4	13.79%	
USGS- Coastal Storm Modeling System (CoSMoS)	4	13.79%	
FEMA- HAZUS Mitigation Planning	14	48.28%	
Other (Please specify)	12	41.38%	
(Did not answer)	5	17.24%	
Total Responses	**94**		20% 40% 60% 80% 100%

ASSESSING IMPLEMENTATION

OPTIONS-

Reviewing and selecting adaptation implementation actions is guided by multiple factors: perspectives of those making decisions; understanding of issues, options and benefits; risk assessments; and funding to name several. Respondents were asked to note criteria used when evaluating potential flooding adaptation measures. Initial installation costs (85%), system life spans (78%) and ongoing maintenance costs (74%) were identified as important. Avoided damage costs, whereby potential damage or rebuilding costs are potentially

negated by spending more funds upfront on adaptation measures (i.e. upsizing a culvert being replaced) was noted as being done but to a lesser degree (48%).

Q20. Which of the following are assessed concerning community infrastructure and FRAP efforts?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Installation costs	24	82.76%	
Maintenance costs over time	20	68.97%	
Life span of systems	21	72.41%	
Avoided damage costs	13	44.83%	
Ancillary benefits	13	44.83%	
Costs of doing nothing	14	48.28%	
Other (Please specify)	4	13.79%	
(Did not answer)	1	3.45%	
Total Responses	**110**		20% 40% 60% 80% 100%

Along with selecting from the options presented with this question, respondents were asked to identify other criteria used to assess possible flooding related adaptation measures:

CRITERIA USED TO EVALUATE POTENIAL ADAPTATION MEASURES

PROJECTED--ACTUAL DAMAGE TO BUILT ENV.	PERMIT-TING	BENE-FITS	DATA	ECONOMICS	SOCIAL	FUND-ING	OVERALL OPTION ASSESS-MENTS
Impacted properties	Impact of existing regulations on approval feasibility	Environ-mental co-benefits	Use the best modeli ng inform ation	Lifespan assessment	Citizen awareness	Funding option cost-benefits	Need vs. competing priorities
Degree of potential vulnerability	Environmental permitting issues	Economic benefits	SLR data; flood maps	Cost effectiveness	Community buy-in	Availab ility of state-federal funds	Option already identified in plan
Critical asset		Longevity of measures		Maintenance requirements		Local match require ments	History of flooding
Impact on essential services				Local match requirements			Economic-physical-social cost-benefits
Age of existing infrastructure				Preservation of tax base			Integration with ongoing planning efforts
Infrastructure replacement costs				Positive economic benefits			Risk levels
Potential for loss of life-property							Time frame horizons
							Equity issues

FUNDING MECHANISMS-

The availability and type of funding drives how decisions are made about implementation and the types and scale of projects that are initiated. The type of financing is key, but issues such as the availability of funding options along with knowledge of how options work will drive decision making and affect the speed of implementation.

Funding normally will be designated for use for planning and study, design, permitting or construction/maintenance efforts. The survey sought to identify what funding streams are being used for the implementation of adaptation work.

Based on the high response rate municipalities are focusing on their operations and maintenance budgets (70%) and the capital planning process (74%) to address adaptation. Outside of city hall, state resilience grant programs (70%) and federal funding via the FEMA Hazard Mitigation Grant Program (78%), the FEMA Pre-Disaster Mitigation Program (63%) and the NOAA Sea Grant- Coastal Resilience program (41%) are being utilized for vulnerability assessments, planning and action efforts.

The FEMA Pre-Disaster Mitigation Program is being replaced with the new Building Resilient Infrastructure and Communities (BRIC) program. The intent of BRIC is to increase community resilience via projects that reduce impacts and reactive disaster spending. The goal is to increase diverse public-private partnerships that can lead to shared funding mechanisms or designs.

Other utilized funding sources noted by respondents included:

- National Flood Insurance Program (29%).
- HUD CDBG Disaster Recovery Program (26%).
- Bond Programs (33%).
- Public-Private Partnerships (30%).
- State Revolving Loan Funds (33%).

Q18. Identify which funding sources are used for FRAP implementation programs?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Municipal operations and maintenance budgets	20	68.97%	
Capital planning programs	21	72.41%	
FEMA Flood Mitigation Assistance Program	13	44.83%	
FEMA Pre-Disaster Mitigation Program	17	58.62%	
National Flood Insurance Program	8	27.59%	
FEMA Hazard Mitigation Grant Program	21	72.41%	
HUD CDBG Disaster Recovery Program	7	24.14%	
Small Business Administration Disaster Loans	3	10.34%	
Federal Highway Administration Emergency Relief Program	6	20.69%	
USDA Natural Resource Conservation Service Emergency	3	10.34%	

Watershed Protection Program- Floodplain Easement Program			
State Resilience Grant Programs	20	68.97%	
NOAA Sea Grant- Coastal Resilience	12	41.38%	
Bonds (Revenue, Green, TIF)	9	31.03%	
Performance Contracts	1	3.45%	
Resilience Fees and Bonds	1	3.45%	
Public-Private Partnerships	8	27.59%	
State Revolving Loan Funds	9	31.03%	
Other (Please specify)	5	17.24%	
(Did not answer)	0	0%	
Total Responses	**184**		20% 40% 60% 80% 100%

WHAT GUIDES IMPLEMENTATION-

CATALYSTS & IMPEDIMENTS-

The useful life of and the need for repairs or replacement of infrastructure such as bridges, roads and other municipal facilities can be calculated. With that somewhat exact information decisions can then be made concerning when work will need to be done and what the estimated costs will be.

Even with evolving models and projections which are providing more micro-level and detailed data about climate related flooding over time, there is uncertainty about the actual scale, scope, distribution, timing and impacts of potential flooding. Such uncertainty can lead to perplexity and confusions about when and how to implement adaptation measures and what levels of risk are justified.

Based on responses, decisions and actions are being guided by the following frameworks:

- Implement programs with short-term benefits (41%).
- Initiate lower cost programs first (37%).
- Implement programs that provide ancillary benefits and/or avoided costs (67%).
- Coordinate efforts with state and federal programs (67%).

Respondents also commented that options with lower costs and higher risks were worthwhile, and that engaging in short-term programs that can be expanded or adjusted over time as conditions change makes sense.

Q6. How do issues relating to climate change impact uncertainty (extent-timing-distribution), evolving climate change projections, and impact time frames guide decision making and implementation efforts to address coastal flooding impacts? (check all that apply)			
Responses	**Responses**	**%**	**Percentage of total respondents**
Implement programs with short-term returns and benefits	12	41.38%	
Initiate lower cost programs first	10	34.48%	
Use planning-zoning-building code-hazard mitigation regulatory tools for gains over time	10	34.48%	
Coordinate efforts with state-regional-federal programs	18	62.07%	
Implement programs that provide ancillary benefits and/or avoided costs	18	62.07%	
Other (Please specify)	8	27.59%	
(Did not answer)	2	6.90%	
Total Responses	**78**		20% 40% 60% 80% 100%

Based on issues surrounding the uncertainty, timing, scale, scope and distribution of climate change impacts officials appear to feel that adaptation efforts should be structured with flexibility and phasing, and should have ancillary benefits to the community. Faulty decision making and/or the incorrect or inadequate commitment of resources is a key concern.

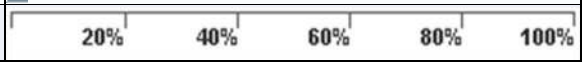
Q8. Rank the following for their importance in implementing FRAP initiatives:							
Answer	**Rank 1**	**Rank 2**	**Rank 3**	**Rank 4**	**Rank 5**	**Rank 6**	**Weighted Rank (Score)**
Uncertainty about climate change time frames means that FRAP related policies and programs should have flexibility and phasing aspects built into them	12	6	4	3	0	3	1 (130)
Along with addressing flooding, strategies should provide ancillary benefits to the community	5	10	4	4	4	1	2 (117)
It's important that efforts don't require extensive human vigilance or excessive annual maintenance	5	0	9	7	3	4	3 (97)
Incorrect or inadequate commitment of resources due to uncertain or wrong projections or faulty decision making is a key concern	4	6	3	5	5	5	4 (96)
Political value is a goal along with addressing flooding	1	3	7	4	4	9	5 (78)

Prudent risks should be taken	1	3	1	5	12	6	6 (70)
Did Not Answer							1
Total Responses							**29**

Coastal adaptation efforts are normally categorized as follows:

- **Protection/Defend-** Advance existing defense lines with land acquisition; beach nourishment; artificial dunes; seawalls-dikes-storm surge barriers; remove invasive or restore native plant species; reduce erosion; implement grey or green infrastructure.
- **Accommodation-** Increased flexibility; flood proofing; flood resistant agriculture; flood hazard mapping; flood warning systems; replace armored defenses with living shorelines; elevate structures; install channels and pump stations.
- **Retreat-** Allow wetlands to migrate inland; shoreline setbacks; managed realignment by breaching coastal defenses; transition utilized land to open space.

Based on survey responses, the majority of implementation initiatives are being focused on protection and defense (89%) although there appears to be significant attention being paid to accommodation work. Additional information would need to be collected to determine what applications are actually being done by category.

Q9. Which categories of adaptation measures have been implemented to address coastal flooding impacts?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Defend- minimize wave action; reduce erosion; protect against storm surges with soft or hard armoring; install grey and/or green infrastructure	25	86.21%	
Accommodate- make space for floodwaters by elevating infrastructure and buildings; install pump stations; construct channels	18	62.07%	
Retreat- transition utilized land to open space; abandon chronic inundation zones; construct living shorelines	9	31.03%	
(Did not answer)	1	3.45%	
Total Responses	**53**		

Sea level rise, coupled with more frequent and stronger storms and daily tidal action, is leading to increased nuisance flooding and inundation issues for coastal communities. Respondents were asked how such problems are guiding decisions and actions to address more frequent and extensive flooding:

IMPACTS OF NUISANCE & INUNDATION FLOODING & RESPONSES

IMPACT	ACTIONS
Road overtopping.	Culvert replacement added to capital schedule if municipal services are impacted.
Local-state roads flooding and low-lying neighborhoods have more flooding; culverts at tidal crossings insufficiently sized.	
Dealing with street closures, private property flooding, erosion and loss of ecosystem services; degradation/loss of function of infrastructure (wastewater, storm water, parking lots, wharves).	
Increased flooding over time.	Blocking off parking, placing road barriers up, periodically closing roads; modeling sea level rise and assessing risk; assessing culvert and other infrastructure to make decisions; involving stakeholders.
State and local roads will flood and need to be closed.	Want to elevate a road to serve as alternate route.
Road flooding.	Roads are closed as needed; roads with erosion being redesigned for stormwater LID efforts; focus on marsh restoration-elevation-expansion.
Expect nuisance flooding to become an issue.	Potential outfall and catch basin issues being evaluated.
Moon tide flooding increasing.	Elevate roads and increase culvert capacity.

On street parking an issue during high tides and houses flooding.	Citizens looking to state/town for assistance and ideas; town working on flood analysis.
Localized flooding on low-lying roads occurring and concern about pump station issues.	With concerns about delivery of essential services are looking at impacts and developing short-long term responses and funding options.
Reverse storm water system flow with tidal flow resulting in sunny day street flooding.	Exploring using tide gates. Goal is to maintain transportation corridors during extreme high tides.
Coastal dune and beach erosion.	Regular meetings to identify short-long term options.
Town flooding due to adjacent marsh.	Flood mitigation studies underway.
Flooding of roads and resulting transportation impacts.	Short-term (structural protection) and long-term (relocation/re-routing) options being explored.
Flooded transportation and public safety routes; loss of protective infrastructure (sea wall).	Examining flood tide pathways to develop solutions.
Visible shoreline erosion near critical infrastructure.	Advancing prioritization of response steps.
More frequent flooding and repetitive losses.	Studying issues and options.

Based on the above replies, increasing flooding is leading to the following impacts:

- Damage to infrastructure (roads, parking, wastewater, storm water, wharves, sea walls).
- Issues with the delivery of essential services and increased emergency management needs.
- Coastal erosion and ecosystem damage.
- Economic costs and repetitive loses.

As a result of these impacts communities are looking at:

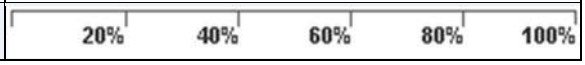
- Culvert upgrades and integrating such work in the capital planning process.
- Studying impacts, generating options and examining funding sources for short- and long-term efforts.
- Implementing LID and marsh restoration projects.
- Engaging in flood assessments and engineering work to assess infrastructure upgrades and relocation.

In line with the impacts and responses noted above, respondents were asked to identify flooding related issues that serve to advance adaptation implementation. Chronic inundation from tidal flooding (67%), significant storm events (96%) and coastal erosion (74%) were noted as key incentives for taking action. Similarly, damaged or destroyed infrastructure (59%) and the inability to delivery essential services (44%) were deemed as important catalysts for engaging in adaptation efforts by respondents.

Q14. Which flooding related issues have served as an incentive for FRAP adaptation planning and implementation?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Chronic inundation from tidal flooding	19	65.52%	
Significant storm events	27	93.10%	
Coastal erosion	20	68.97%	
Damaged-destroyed infrastructure (roads, bridges, water-sewer, schools, other municipal facilities)	18	62.07%	
Loss of tax revenue and loss of value to damaged-destroyed commercial and residential properties	7	24.14%	
Inability to deliver essential services	13	44.83%	
Social-economic-cultural impacts to the community	8	27.59%	
(Did not answer)	1	3.45%	
Total Responses	**113**		20% 40% 60% 80% 100%

Community involvement and support are key for advancing adaptation initiatives. Survey respondents agreed that there's a correlation between established community support and the ability to implement flooding programs and policies (81%). They were also asked to provide comments concerning community support.

Q12. Is there a correlation between greater community support levels and the ability to implement FRAP programs and policies?			
Responses	**Responses**	**%**	**Percentage of total respondents**
More support equals greater progress	24	82.76%	

Support is helpful for initial actions but not critical for ongoing efforts	6	20.69%	
(Did not answer)	1	3.45%	
Total Responses	**31**		

COMMUNITY SUPPORT AND ADAPTATION IMPLEMENTATION

Maine is a home rule state. Expenditures, actions, policies and land use regulations need to be placed on the municipal ballot and voted on by residents.
Limited funding and staffing require a focus on issues that demand action based on political will, available funding and high priority as far as public health and safety and welfare. Elected officials respond to community needs and town meeting votes the spending. Broad public support is important to move projects forward.
Getting the public and town departments to support a project is key to its success. Funding is doled out by the public.
With limited funding, actions are usually targeted toward communities that are on board.
If the community understands the importance and lets their councilors know, we have a greater chance of funding and push for progress.
The community is involved especially if it affects their property. Many residents are supportive of adaptation measures as they have seen the effects of coastal storms and flooding first hand, and have witnesses the increase in frequency and intensity.
Community support is needed for larger projects such as shoreline protection/resiliency measures.
Community buy-in is critical to adaptation planning.
There needs to be support from key stakeholders through all phases of project implementation (design, permitting, construction).
In NH voters vote on issues, so more support leads to greater success.
Without support from elected local decision makers and residents at Town Meeting, it is difficult to make substantive changes.
Community support is key to moving initiatives forward and for maintaining projects over the long term.
The more stakeholders that are engaged the more they take ownership of mitigation measures.
General community support is important, but much more important are the officials and stakeholders and decision makers in terms of making flooding related adaptation projects a priority and funding and implementing projects.
More than half of the residents living directly on the coast feel the problems will not affect them during their lifetime.
The more political pressure, the better options for funding.

To understand more about the drivers and roadblocks for implementing flooding related adaptation projects respondents were asked to identify those topics that have been or are actual catalysts and impediments. This question was a general higher altitude look, and specific details on how each topic is or had been a catalyst or impediment was not solicited.

IMPEDIMENTS AND CATALYSTS FOR IMPLEMENTATION

TOPIC	CATALYST (%)	IMPEDIMENT (%)
Funding	78	100
Technical Resources	56	52
History of Flooding & Disaster Recovery Efforts	67	4
Political Will	67	63
Community Buy-In	56	44
Useful Flood Projection Information	37	19
Economic Analyses	30	22
Governance Structure	15	37
Legal Issues	26	44
Comprehensive Planning Efforts	41	7
Social-Cultural-Economic Issues	11	22
Disruption of Essential Services	52	3

RELATIONSHIPS BETWEEN

ADAPTATION ACTORS-

State, federal and local governments are intricately bound through statutory and regulatory relationships, as well as the common ongoing objectives of fostering environmental protection, economic growth and social cohesion. Addressing climate impacts through adaptation actions is a primary way to attain those goals. As the climate adaptation field evolves, governmental agencies at all levels, the private sector, citizens, NGOs and academic institutions are strengthening existing and building new relationships, are identifying issues that need to be addressed and are figuring out diverse ways to generate adaptation successes.

The survey asked about relationships and how adaptation implementation is being advanced or hindered by existing regulatory and programmatic frameworks between actors.

ARE FLOODING RELATED POLICIES-PROGRAMS ASSISTED OR HINDERED BY STATE & FEDERAL ACTIONS AND REGULATIONS?

Guidance, technical assistance and funding support from federal and state entities assists local efforts but only if there's adequate support and technical assistance to pursue, receive and utilize funding.
Certain state programs and staff help local efforts, but a lack of cohesive state policies and frameworks causes problems.
State and federal level support and grant funding helps but state and federal regulatory policies can hinder implementation. There needs to be better alignment of regulatory policy and mitigation efforts. In MA there's not enough coordination between local government and the state since regional government is not strongly organized. Outreach and facilitation of coordinated efforts between a variety of agencies covering regulatory, roads, bridges, power, water, storm water, etc.) is needed to implement effective spending of limited available resources. This would lead to a better framework for regional cooperation and the allocation of resources.
Both. Grant funding assists and is essential. Regulations sometimes get in the way of innovative approaches.
The Army Corps of Engineers will not consider buyouts of vulnerable areas unless there is 100% participation. FEMA often pays for rebuilding in at-risk areas without consideration of future conditions (answered from a state perspective).
Most state and Federal grants have a resilience component to them so it assists.
The state has been an extremely beneficial resource for funding resilience efforts. Many small towns would not be able to complete many of these programs without the funding. They are very supportive throughout the program, offering assistance and guidance. Permitting duration is the most time consuming for implementation. Planning takes time as well to ensure that the public is fully informed and engaged.
Assisted. The NH Coastal Risk and Hazards Commission was key to advancing adaptation work in NH. I imagine that other state/federal actions can be hindering though.
The permitting process is complicated, expensive and lengthy.
Limited funding, lengthy and restrictive policies which are not always consistently applied and vary across state-federal agencies.
Assisted by state level technical assistance and federal funding.
Hindered unless funding is also made available.
Subject matter is new, or at least old efforts repackaged under flooding adaptation. Federal and state agencies need to lead with policy and funding that municipalities will follow.
Hinders and assists. In RI state regulators now require assessment of coastal flooding impacts for permitted projects. This helps guide the process. However, in some cases it is difficult to be creative and implement experimental or unique mitigation measures within the existing regulatory framework. There is also shifting consensus on SLR projections which can vary from agency to agency.
Regulation can preclude some adaptation options.

State level programs and coordination such as the Municipal Resilience Program and the Resilient Rhody strategy have helped provide planning, design, implementation assistance for community projects.
Hindered. Out of date regulations do not allow for novel mitigation activities or for pilot projects or research to test out of the box techniques.
Limited state and federal funding available.
State and federal level actions have both helped and hindered. Programs like the state's Municipal Vulnerability Preparedness program have helped focus attention and resources. Multiple, overlapping and sometimes incompatible regulatory requirements for anything along the shoreline has definitely driven up costs and extended the amount of time for taking action.
Need a Federal buyout program.
Permitting and people's wants often conflict.

A summary of respondent's points included:

- Federal/state guidance-technical assistance-funding helps municipalities engage in efforts they might otherwise not be able to and helps focus attention and advance efforts.
- There is a lack of cohesive state policies and frameworks.
- Federal/state regulatory policies can hinder local efforts; need better alignment between regulatory policy and mitigation.
- Need better coordination among state agencies concerning regulatory programs and infrastructure.
- Restrictive policies applied inconsistently across Federal/state agencies is an issue.
- Need better policy/funding mechanisms from Federal/state levels.
- State requirements for assessing coastal development impacts by project is a plus but state regulations can limit implementing innovative/experimental measures.
- Permitting is complicated, expensive and lengthy.
- Shifting consensus on SLR projections among state agencies causes confusion.
- Multiple, overlapping, incompatible regulatory requirements can drive up costs and extend time frames.
- Weak regional government hinders state/local coordination; stronger regional efforts are needed.
- Commissions with members with diverse backgrounds can enhance efforts.

Concerning collaboration between communities that are engaged in adaption respondents offered the following:

COLLABORATION AND COORDINATION AMONG COMMUNITIES WITH IMPLEMENTATION

Portland and S. Portland, ME working together on an initiative called "One Climate Future."
Southern Maine Regional Sustainability and Resilience Program established by regional planning organization and 6-member coastal municipalities to address climate issues and coastal resilience, specifically flood adaptation and mitigation efforts. Other grant funded coastal flooding related projects ongoing in S. Maine involving multiple municipalities.
Regional planning organizations and regional economic development organizations have provided assistance, capacity, and leadership in some parts of the state.
We have been able to coordinate on infrastructure- bridges, sea walls and emergency response, and outfall improvements. Now working with abutting communities on SLR and wave impacts, flooding for our local bays.
On the North Shore of MA, we all participate in collective discussions and actions concerning the Great Marsh. We have put together a Great Marsh adaptation plan for the region.
CRMC- the state CZM agency, has many initiatives for identifying potential flooding adaptation projects and working with communities for funding and construction of coastal resilience green infrastructure projects. Currently developing an inventory of potential projects and funding the design for several projects.
New Bedford and Fairhaven collaborated on an MVP grant to evaluate shared harbor vulnerabilities. This partnership is expected to continue. Shared waterways, streamlining regulations and procedures. Regional plans and projects.
Bass River Dredging is a multi-community effort with Yarmouth county level emergency response planning and sea coast transportation corridor project.
The Martha's Vineyard Commission, which is the Vineyard regional planning agency, is working on an island wide climate adaptation plan.
Communities collaborate on shared resources like roads, estuaries and like to learn from each other.
Collaboration through regional planning agencies and other local environmental organizations.
Newburyport, Newbury and Salisbury on resiliency for the coast in the Merrimack River area.
Working with the Rockingham Planning Commission on a variety of multi-town initiatives in Seacoast, NH.
Municipal Resilience Program-R.I. Infrastructure Bank-TNC
Coordination at the marsh/estuary scale in which restoration and resiliency benefits large segments of the coastline.
Multiple advocate groups throughout communities crossing borders along with State/Federal and non-profit support.

RETREAT-

The use of managed retreat as an adaptation strategy is being explored with more interest by communities. Managed retreat is a proactive, planned process where infrastructure, structures and residents are moved away from vulnerable areas before impacts occur. This is different from buyout programs where structures are purchased after single or multiple losses and the open land is then utilized as part of flood control efforts. Managed retreat requires addressing a myriad of planning, financial, equity and legal issues, and can be looked at in comparison to other adaptation strategies covering protection and accommodation.

Respondents were asked a series of retreat related questions to determine the extent to which retreat is being studied or implemented, to see how the process works, and to understand the issues are around retreat.

IS RETREAT AN ADAPTATION MEASURE THAT IS BEING STUDIED OR IMPLEMENTED

Preliminary discussions occurring.
The Wells Reserve (ME) is hosting a graduate student who will look at decision-making in the context of relocation.
Trying to get an alternative transportation route more inland which is a form of retreat. However, the state highway is not going away. It cannot be elevated since it is densely populated with important businesses on each side.
It has been studied and implemented in a few areas, but nothing really comprehensive. Retreat projects have been done for infrastructure more than houses. After Sandy many houses were required to retreat within the property boundaries.

Not specifically studied but is an option to be considered. Not a necessity so far.
We always keep retreat in mind though it would be a last resort. Phased retreat could be more palatable to the public if needed.
We are considering acquiring some developed parcels within the flood zone.
Looking at the development of coastal buyout or flood recovery and relief programs and salt marsh migration pathway land acquisition.
It has been talked about but not embraced by municipalities (yet) as property tax dollars make up municipal budgets.
Relocation of critical infrastructure away from inundation areas is considered.
We're located in Inner Boston Harbor. The debate over the construction of a hurricane barrier needs to play out before retreat gets more attention.
Retreat is being studied in conjunction with increased density in and better utilization of upland area.
Being studied as part of MVP grant.
There is a state working group looking at managed retreat as a strategy.
No, too politically charged at the local level.
Yes, retreat implemented at two coastal beach/parking areas.
Retreat has been identified as an inevitable step to be studied during the coming years, but the present focus has been on defense.
To date, retreat is not a word accepted locally.

IF RETREAT RELATED MEASURES HAVE BEEN IMPLEMENTED:

HOW LONG HAS RETREAT BEEN USED
Early 1980s
Two years
For properties impacted by 2010 flooding
Since 2008

HOW MANY PROPERTIES HAVE BEEN PURCHASED
70+
1

WHERE DO BUYOUT FEES COME FROM
Army Corps of Engineers, FEMA, grants
Community Preservation funding and Town Meeting
National Resources Conservation Service, FEMA mitigation funds

AS PART OF RETREAT WHAT REGULATORY CHANGES WERE MADE TO PREVENT FUTURE DEVELOPMENT IN FLOOD PRONE AREAS

Retreat was required under current regulations.
Future retreat may require expansion/modification of Designated Port Areas.
The building code doesn't prevent building. The only way to prevent is to purchase fee simple or development rights.
A CR was placed on the land bought.
In Durham, NH a flood hazard overlay district encourages building to higher standards in the projected floodplain in addition to requirements in the current mapped floodplain.
Conservation/floodplain easements.
Looking at a model floodplain bylaw with neighboring towns through grant from Cape Cod Commission, the regional planning agency.
Zoning will only address future growth. Sadly, the entire coastline is already developed on 5,000 sq. ft. lots.

FOLLOWING RETREAT INITIATIVES HOW HAS THE VACATED LAND BEEN UTILIZED?

Retreat was limited to relocation within the property boundaries so the land remained in private ownership unless it had eroded away.
Parks or return to natural buffer function.
Conservation land.
Returned to coastal dune beach.
Left as an open lot.
Where private buildings have been lost to storm damage, new buildings have replaced them in some cases along the coast.

Summary of Retreat Issues-

- Relocation of key infrastructure is looked at as retreat; retreat for infrastructure is more common than for houses; beach parking structures have been relocated.
- For the most part retreat is not a front burner issue for communities at this point although there are discussions and some studies occurring; looking at retreat in conjunction with increasing density and better utilization of upland areas.
- Retreat is not a necessity thus far, is on people's minds, but would be a last resort; focus on short-term will be on defense.
- Phased retreat could be more palatable for people.
- Efforts to look at purchasing developed properties in the flood zone and buyouts to enhance marsh migration.
- Concern about losing property tax revenue with buyouts.
- Retreat is too politically charged and not accepted locally.
- Buyout resources have included both federal and municipal funds.

- Conservation and floodplain easements are some of the options looked at to prevent future development in flood prone areas.
- Vacated land has been turned into parks, left in its natural state as conservation land and to act as a natural buffer.

Finally, respondents were asked about factors that would make retreat difficult to implement. People's attachment to place and economic-cultural ties was noted as a possible hurdle (67%). Also, the potential loss of revenue from coastal development was ranked as a concern (59%), as was people's preference for the status quo (56%).

Other comments concerning conceivable difficulties in implementing retreat included:

- Response to the demand for public investment to purchase private property; the political will of residents who vote at town meeting.
- Legal precedent and the cost of eminent domain.
- Legal issues and property rights.
- At risk properties are affordable but are not subsidized. Tenants would have trouble obtaining comparable housing. Some tenants also have limited access to transportation and need access to public transportation and local services.

Q25. Which of the following factors would make retreat difficult to implement?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Economic gains from coastal development	16	55.17%	
Subsidized insurance rates	12	41.38%	
Disaster recovery funds	7	24.14%	
Diverse risk perceptions	13	44.83%	
Attachment to place/cultural-economic ties	19	65.52%	
Preference for the status quo	15	51.72%	
Other (Please specify)	4	13.79%	
(Did not answer)	5	17.24%	
Total Responses	**91**		20% 40% 60% 80% 100%

INTERVIEWS-

Interview questions were formulated to determine the focus of flooding adaptation programs being undertaken by municipalities, state and regional agencies and commissions and NGOs, and to identify what has been implemented and what is planned or desired. Conversations with the 32 interviewees were structured to address implementation issues from the perspective of:

- Financing
- Governance
- Design and permitting
- Coordination concerns
- Modeling and cost analysis
- Decision making and attitudes
- Retreat

GENERAL OVERVIEW-

Much of ongoing adaptation initiatives for coastal communities still focuses on vulnerability assessments and the development of action plans. State and federal grant programs that provide funds for municipal resilience efforts are widely used by coastal communities for work that focuses on:

- Community outreach and stakeholder buy-in programs.
- Regulatory work addressing upgrading master plans, zoning and floodplain ordinances, and integrating hazard mitigation and adaptation planning.
- Enhancements to infrastructure with green projects being integrated with work addressing roads, wastewater and storm water systems, beaches and other coastal features.

Interviewees noted the need to further adaptation implementation work and highlighted the importance of the following topics in making those advances happen:

- Funding
- Political support and community buy-in
- Attitudes and perspectives
- Design and permitting issues
- Coordination concerns

Officials discussed how existing conditions or potential problems such as flooding of septic systems or overtopping of access roads to hospitals can be catalysts to spur adaptation initiatives. Some noted how pictures, stories and anecdotes can be effective tools to explain history and future scenarios, and can generate buy in and support. But even with acknowledgement of actual or potential issues, uncertainty about impact time frames and the scale of impacts can make it difficult to decide

what to do. Such uncertainty can hinder decisions on spending money and can generate concerns that the wrong choices will be made. A related issue voiced about uncertainty concerned the long-term effectiveness of adaptation efforts in terms of sea level rise projections versus money spent and efforts made.

While communities utilize grant funding for consultants to provide planning and engineering work, respondents noted that it can take time for the actual work to be completed, for the community to trust consultants and their work, and for there to be agreement with the information being presented. This can stall further work covering decision making and implementation on top of the fact that conditions and issues may change over time.

Interviewees raised concerns about issues involving design and permitting and coordination. It was noted that projects need to be developed to a certain point to secure funding for implementation work covering final design and permitting. This requires upfront funding for assessment/planning/decision making/preliminary design work. A lack of staff and/or funding capacity can hinder efforts to advance programs.

Even with the integration of adaptation measures into existing municipal planning and operations work there can be issues surrounding needs vs. resources, risk levels, timing, impacts, buy in, prioritization, and benefits all of which can shape decision making and pathways. One respondent stated that the bottom line for adaptation should be to look for actions and compromises to help communities and that allow people to keep their properties and their property values. He noted that water should be channeled away in some areas and accepted and worked with in other areas with the goal of advancing practices, measures and policies to do that.

Interviewees observed that protecting the natural resources of their coastal communities is critical for both adaptation and for continued community vitality. Accommodating the expansion and migration of marshes was rated as very important by respondents. To that end, land use and zoning upgrades and the desire to accelerate open space acquisitions and land conservation were identified as important efforts to pursue.

Communities are looking at restrictions on rebuilding and/or not allowing building in certain areas, and are requiring that structures be elevated based on flood projection data. Master plans and floodplain ordinances are being revised, and municipalities that are largely built out are addressing redevelopment options in coastal floodplains via their master plans. Flood hazard overlay districts are an option but some planners stated that they could generate dissent and approval problems. Building on the desire to protect and enhance coastal resources,

some master plans are being updated in phases. Initially, coastal hazards are being identified and subsequent work will focus on economic development and resource protection strategies.

With uncertainty about the timing, scope and impacts of climate flooding some communities are taking an incremental or wait and see approach to adaptation. The uncertainty factor plays into how communities look at risk and make decisions. In cases, municipalities are addressing the low-hanging fruit via green infrastructure upgrades, while in other instances communities feel that undertaking measures that address flooding and provide the greatest number of benefits is the way to proceed. Interviewees felt that work covering master plans, zoning ordinances and hazard mitigation plans advances efforts and provides frameworks for subsequent action and support.

Infrastructure is the veins and arteries of a community. Because of the key roles it plays in delivering essential services and in guiding development, municipalities are beginning to integrate adaptation measures into infrastructure work. Officials are looking at how infrastructure can be upgraded or relocated based on climate impact assessments and are dovetailing infrastructure work with land use planning efforts.

Green infrastructure work is being woven into projects where appropriate with a resulting increase in resiliency. If older infrastructure needs to be upgraded or relocated, including adaptation work with the project can help move projects up the priority list and can provide ancillary benefits to the community.

Communities are incorporating infrastructure related adaptation measures into more traditional efforts covering culvert and tidal crossing work, nutrient control and water integration measures. As an example, flood projection data and modeling are being used to examine culvert sizing with road design when looking at replacing, relocating or raising roads. For storm water infrastructure, communities are conducting micro-level neighborhood assessments of systems to determine upgrade parameters to address current and future flooding. Municipalities are looking more closely at the life spans of their infrastructure. If sea level rise will reduce the projected long-term longevity of a system, or sizable investments will be needed to ensure its integrity, then relocation of the infrastructure or retreat from an area may be prudent.

FINANCING-

In line with the results of the survey, officials noted that financing is the biggest hurdle to overcome to advance adaptation implementation. Currently, state and federal grants are the primary funding source for planning, design and permitting work. Officials noted that grant programs are key for initial study and planning efforts and to build momentum. Tying in with local governance capacity, some respondents noted that it's vital to have resources for grant writing to keep momentum moving forward.

Even with available funding options communities may be averse to advancing projects. Using FEMA funds may not be pursued since towns may feel the process is too difficult. Similarly, communities might not want to incur debt through bonding. Or, setting up a storm water utility might not happen since utility fees may be looked at as taxes by residents.

For smaller communities with limited resources it was suggested that communities group together and pursue regional approaches for implementing options and for securing funding. Regional planning commissions and watershed associations were identified as resources to assist with implementation including in-kind labor contributions.

GOVERNANCE-

One interviewee noted that Resilience equals Projects+Policies+Practices. As the adaptation field evolves, communities are assimilating efforts into the regulatory, capital planning and operations segments of government. Incorporating adaptation into housing plans, hazard mitigation and emergency management can help advance resilience. Projects that address flooding as well as enhance public access, increase public safety, provide economic benefits and increase recreation opportunities can be prioritized and provide multiple benefits. One community with a municipal utility noted that enterprise funds can be used to complete adaptation projects. Here, rates can be raised to pay for efforts and the work can be tied back to the mission of the utility.

A number of officials declared that increasing governance capacity is key for successful adaptation. Staff coordination, expertise and time availability, along with a lack of staff in small towns, were noted as impediments for adaptation efforts. To increase staff coordination, education and buy-in one local government uses an Inreach program. The issue of consistency came up in the interviews.

Officials spoke about the need for consistency with regulations and approaches across town boards, and the ability for departments to work together. Consistency as it relates to state-federal-local relationships also was raised and is explored further on.

One area where capacity is an issue, and this was noted several times, is in the area of administering projects. Whether it's filing and coordinating grant applications or getting through a permitting process, a lack of staff capacity can slow progress which can lead to time delays, additional impacts and higher costs.

Political will and support are required for successful adaptation, and respondents noted that concerns raised by businesses or citizens, say about road access during flooding, can spur action. Similarly, municipal efforts with infrastructure upgrades, such as raising a system, can cause residents to look at their own properties and take steps to minimize flooding damage where they live.

Along with integrating adaption work into regulatory and planning functions, more municipalities are coordinating adaptation efforts with capital planning and budgeting. Looping adaptation projects into the capital planning process is a way to address infrastructure and facilities issues as well as derive broader community benefits.

DESIGN AND PERMITTING-

Design and permitting issues were discussed by a number of officials. They felt that standardizing infrastructure systems designs, along with revamping permitting processes, would reduce time frames and costs and would allow for more implementation. One official noted that it can take 2-3 years for the design and permitting process to be completed and by that point issues and needs might have changed.

For design, officials noted that developing more cost-effective standardized designs for bridges and sea walls would be beneficial. They felt that engineers and officials at all levels need to think outside the box and explore options that can provide other benefits. Existing infrastructure should not be replaced with what's already installed but alternate approaches including green options should be incorporated as they allow. Acknowledging that issues and conditions will be site specific, officials still wondered why every town needs to develop their own concepts and designs which can increases costs and time?

Concerning permitting, respondents noted that different requirements between agencies, the data they use, and diverse review time frames can impact efforts. One city noted a project dragged on due to competing interests between the U.S. Army Corps of Engineers (water infrastructure) and the Environmental Protection Agency (natural ecosystems) on a

tide gate project. Also, time can lag when municipalities need to provide in-kind services to help administer projects.

Interviewees stated that permitting and conformance to state and federal standards and regulations can be extensive, can generate tremendous paperwork, can preclude options, and can take a great amount of time to complete. One community with large marsh areas wanted to help the marsh act as a better sponge by addressing invasive species but ran into permitting issues when trying to advance the project.

COORDINATION CONCERNS-

Flooding history from storms and tidal inundation, repetitive physical and financial damage with subsequent rebuilding, uncertainty about impact time frames, scales and risk levels, a desire or pressure to engage in adaptation, and questions about funding all combine to make communities feel that something needs to be done but how and when.

Climate change flooding impacts do not respect town boundaries. The projected scale of flooding impacts along with the critical issues of financing and potential retreat means that no one community will be able to address adaptation on their own. Collaborative public-private and local-regional-state efforts will be needed for successful planning, design and funding.

A number of interviewees raised issues about coordination among and between organizations and agencies, and how that can advance and impede adaptation work. Many groups with alternate perspectives, mandates and agendas are involved with design and permitting, and respondents said that efforts are needed to increase cohesiveness and streamline and accelerate procedures. Examples of areas to address that were raised include: how different state agencies understand sea level

rise; permitting requirements for different federal agencies who play a role in coastal management; state versus local agency perspectives; current standards from the engineering community; traditional versus thinking outside the box perspectives for project development and design.

Even within larger communities that might have more staff capacity respondents said that projects happen randomly, that there's limited tie-in with other departments, and that it's difficult to maintain an ongoing inclusive approach with adaptation efforts. Some noted that the scale of flooding impacts requires that a regional approach, versus a town-centric position, is adopted for adaptation endeavors. Local issues can be addressed but that work should be overlapped with regional efforts. With this framework funding can be generated, cost effectiveness can be increased, and support can be built for further efforts. Some noted that execution is the key variable and that there needs to be someone who can connect multiple players to advance efforts.

Along with state and federal relationships with municipalities, respondents noted that research centers such as academic institutions, regional planning agencies, citizen commissions and NGOs all supplement local efforts with funding, technical assistance and

energy. Interviewees said that adaptation both at the local and regional levels should be as holistic as possible. People with diverse backgrounds and perspectives need to be able to work together to see where there are multi-benefit projects (i.e. flooding and water quality) and focus on those efforts. One respondent stated that effective collaboration can lead to successful pollination.

More and more municipalities are realizing that flooding is not a one-town issue and that regional collaboration is necessary. Several towns in Rhode Island are working together on relocating generators for pump stations that are located in a floodplain. These same towns are working together to share stormwater designs to address infiltration issues, and are working on road designs for roads that end at water. Another cooperative effort noted by respondents included three adjoining Massachusetts coastal towns who looked at erosion and decreases in property values which led to subsequent efforts to address flooding. Several of those same communities are now applying for a co-grant that will have a regional adaptation focus.

Respondents discussed the value of networking, relationship building and information transfer. They noted that state, local and regional efforts are shaped by individual and agency missions and perspectives, and that this can cause disjointedness and result in impediments to effective, timely and cost-effective projects. Some interviewees praised the fact that there are so many diverse groups working on adaptation. They noted that differing perspectives can be both a plus and a minus as far as moving things along. With numerous organizations addressing climate adaptation interviewees wondered if there could be too much overlapping or too much competition so that things that should be addressed fall through the cracks. The question was raised concerning if too many of the same things are being done the same way?

MODELING AND COST ANALYSIS-

Cost-benefit assessments and modeling can be utilized for prioritizing adaptation options and for assisting with decision making. Such tools can be used to identify future avoided costs for implementing measures now that are designed to reflect future scenarios, and for identifying economic and social benefits. Respondents agreed about the value of such calculations but for the most part are not doing it due to a lack of in-house capacity and assumed cost issues. Comparing economic modeling to sea level rise projections, interviewees noted the higher level of familiarity they have with sea level rise data. Even with an increasing use of such information, officials noted that sometimes tools advance quicker than the social-political capacity to use them.

Municipalities recognize the value in conducting cost-benefit analyses and want to gravitate toward doing it. One community wants to conduct cost-benefit analyses of projected flooding impacts and compare the costs and benefits of implementing various options versus not doing anything. Another municipality stated that they want to look at the costs and benefits of raising roads, including ancillary benefits, and determine damage avoided costs by conducting the infrastructure work. Finally, another town is applying for a

grant to model which culverts, roads and water supply components will fail under various storm surge-rainfall scenarios so they can develop adaptation programs to be implemented over time.

Modeling is being used to look at sea level rise projections and determine whether beach nourishment or other measures are appropriate to implement. In a different vein, modeling is being used to look at potential residential and business septic failures bases on sea level rise projections.

Other forms of modeling being utilized includes Geographic System Information mapping. In one case GIS was used to survey parcels larger than five acres to categorize the parcels by different natural resource (farmland, water resource, flooding issues, habitat). The project identified key properties that should be conserved for adaptation initiatives.

DECISION MAKING AND ATTITUDES-

Interviewees spoke of developing and implementing projects and programs in a planned-prioritized-coordinated-integrated manner. Whether it's addressing low-hanging fruit that's less costly and can derive some flooding benefits, or implementing more costly programs that can result in multiple benefits, respondents said that the intent should be to continue efforts to build momentum, successes and ongoing political and community support. They noted that the availability of decision-making criteria, including economic analyses, would be helpful in determining actions to pursue, but that obvious impacts such as road overtopping from tidal flooding or repetitive damage to wastewater systems would be prioritized for attention over other efforts.

Respondents stated that concerns about making the wrong choices based on the uncertainty of impact projections, time frames and levels of risk can stall movement. Hesitancy can lead to adopting a de facto reactive versus proactive approach which can require more costly adaptation and/or rebuilding down the road. Interviewees noted that a hesitancy to implement measures can be based on the feeling that adaptation measures will be costly along with the uncertainty about where funding will come from. Conversely, they noted that hesitancy can result in more expensive adaptation programs.

Most respondents said that funding opportunities will help drive decision making. Having to wait for funding cycles and grant rounds is a key decision-making issue for communities. Interviewees noted that identifying and selecting adaptation measures where there are co-benefits is important.

RETREAT-

Concerning issues around retreat, the survey and interviews revealed that while there have been some actual buyouts most retreat related activity to date has centered around discussions and studies. Compared to other flooding adaptation efforts retreat currently is a much smaller segment of the adaptation pie. While concerns about timing, costs,

implementation and support surround climate adaptation, retreat is all of that including a great deal of emotional energy.

Interviewees noted the issue of deciding to implement adaptation measures so people can stay where they are versus the costs and benefits of pursuing buyouts and retreat at some later date. Whether it's flooding that destroys houses and diminishes tax revenues or a loss of tax dollars from buyouts, municipal officials worry about their ability to provide services. The equation changes somewhat when relocation is added in, with new construction generating tax revenue, but buyouts and new infrastructure for relocation will be costly.

Some officials said they worry about having to eventually pursue retreat after spending resources to implement adaptation measures. They asked if retreat is a separate track that gets addressed simultaneously with other implementation measures and programs? Respondents who work in communities that are built out or don't have higher elevation buildable land raised concerns about how retreat and relocation could be handled. Even with buildable land communities that support adaptation efforts due to erosion and flooding issues may deny that there might need to be retreat at some point and this can preclude even studying the topic. Even if communities acknowledge retreat and begin to examine it a key issue is who pays when it's only certain people that benefit from retreat.

Adding to the emotional level of flooding and possible retreat are the perspectives voiced by residents. One official noted that there are multi-generation residents in town who are now dealing with flooding who are asking the town what they are going to do about it so they can stay. Other officials observed that homeowners, including those with second homes who don't live in a town full time, say they are entitled to being able to stay in their houses and to have working infrastructure to remove water from their property and have guaranteed access to their lots.

CONCLUSIONS-

Based on the literature search, survey and interviews focusing on the implementation of adaptation measures to address coastal flooding issues the following primary conclusions are presented. The conclusions are broken into groups based on the categories covered in the survey and interviews:

- Funding
- Governance
- Design and permitting
- Coordination concerns and relationships between actors
- Modeling and cost analysis
- Decision making and attitudes
- Retreat

GENERAL OVERVIEW-

- The majority of climate adaptation work is still focusing on vulnerability assessments and planning.
- Measuring the effectiveness of adaptation initiatives needs to occur.
- Planning related adaptation is occurring in the areas of hazard mitigation, emergency management and master planning, and to a lesser extent with upgrades to building codes and zoning ordinances.
- For municipal infrastructure, storm water and wastewater systems are the focus of adaptation measures, including green projects. Funding for this work is coming from capital planning and municipal budgets.
- With coastal adaptation efforts covering protection, accommodation and retreat, the majority of work is centered on protection (erosion and storm surge control, green infrastructure), with a smaller degree of work being made with accommodation (elevating buildings, channels, pump stations).
- Accommodating the expansion and migration of marshes was noted as being important for natural resource protection and community vitality. To accomplish this, participants said that land use initiatives, zoning upgrades and accelerated open space acquisitions should occur.
- In cases, master plans are being updated in phases with coastal hazards initially identified. This is followed by the development of strategies for resource protection and economic development.
- Concerning issues covering climate change uncertainty, risk levels, time frames and the scale and scope of impacts, communities are taking different approaches with adaptation. Some are taking a wait and see position while others are addressing low-hanging fruit via green infrastructure. Other communities are adopting an incremental approach while some municipalities are implementing measures that provide the greatest number of benefits.

- Flood projection data and modeling are being used more broadly for infrastructure analysis and design. Communities are looking at culvert sizing when engaging in road work. Other municipalities are conducting micro-level neighborhood assessments of water infrastructure to assess upgrade options to address flooding. Communities are also using flood projection data to examine system lifespans and the costs of upgrades vs. relocation of infrastructure.
- Adaptation efforts can be thwarted by:
    - A lack of social resources, including polarized views and political will, along with financial resources.
    - Development projects that generate tax revenue but also create risks.
    - Policies, protocols and viewpoints from credit agencies, insurers and banks.
    - State and federal regulations, mandates, perspectives and procedures.
    - A lack of locally relevant data covering sea level rise projections and flooding along with usable and affordable economic modeling tools for assessing costs and benefits.

FUNDING-

- The availability and type of funding drives how decisions are made and the types and scale of projects initiated.
- Municipalities are utilizing their operations and maintenance budgets and capital planning programs, along with state and federal resilience grants programs for planning and implementation.
- Even with funding options identified communities may be averse to implementing programs since they feel that the process is too difficult or there are concerns about incurring debt.
- Some respondents discussed the idea of communities banding together to secure funding for implementation.

GOVERNANCE-

- How scientific information is used in bureaucracies is key. Agencies and departments in the same governmental structure can use different sea level rise data and have diverse agendas and perspectives.
- Coordination among departments and their ability to work together, along municipalities having consistent regulations and approaches, was noted as being important. Officials noted that this also ties into the need for consistent and harmonious local-state-federal relationships.
- Knowledge of impacts doesn't necessarily lead to the most cost effective and efficient policy decisions.
- Officials noted that while adaptation work is being integrated across local government sectors efforts are proceeding in limited and isolated fashion. That said,

the integration of adaptation into government operations has led to more successful efforts over shorter time periods.
- Flooding related issues that are serving as incentives for adaptation implementation include: tidal flooding; storm events; coastal erosion; damaged-destroyed infrastructure; the delivery of essential services.
- Staff coordination, staff expertise and time availability, along with a lack of staff capacity, especially in smaller municipalities, were expressed as key concerns.
- Adaptation entails a continuing risk management process. Short and long-term benefits can be obtained by integrating or mainstreaming adaptation into existing governmental policies, practices and investments covering planning, budgeting, capital programming, and operations and maintenance.

DESIGN AND PERMITTING-

- Standardizing infrastructure systems designs and revamping permitting procedures at all levels of government can reduce time frames and costs.
- Different requirements between agencies, the data that is required by permittees and used by reviewers, diverse review time frames, perspectives and mandates can impact efforts.
- Permitting criteria can require tremendous paperwork and preclude proposing innovative options.

COORDINATION CONCERNS & RELATIONSHIPS BETWEEN ACTORS-

- Addressing local flooding issues should be overlapped with regional efforts so that adaptation is solely not town-centric.
- Networking, relationship building and information transfer is key between all who are engaged in adaptation. Missions and perspectives can lead to disjointedness, and too much overlapping or competition among groups can cause critical issues to fall through the cracks.
- It can take time for planning and engineering work to be completed and for a community to build trust in consultants and what's being presented, and this can lead to time delays.

MODELING & COST ANALYSIS-

- Respondents noted the value in conducting cost-benefit assessments and modeling for prioritizing adaptation options and for calculating social and economic benefits.
- A percentage of communities are engaging in such work to compare options versus not doing anything, to determine ancillary benefits of raising roads, or to model the failure rates for infrastructure based on storm surge and rainfall scenarios.
- Economic cost-benefit analyses, integrated coastal zone management and community base adaptation were noted as frameworks being used.

- A lack of in-house capacity or assumed costs was noted as reasons for not conducting such exercises.

DECISION MAKING & ATTITUDES

- Funding opportunities will drive decision making, and having to wait for funding cycles and grant rounds is a key issue.
- Adaptation entails a continuing risk management process. Short and long-term benefits can be obtained by integrating or mainstreaming adaptation into existing governmental policies, practices and investments covering planning, budgeting, capital programming, and operations and maintenance.
- How decisions are made, how uncertainties about time frames and magnitudes are addressed, and how political support is built and sustained is key.
- Current adaptation decisions and actions are being guided by frameworks based on: implementing programs with short-term benefits; focusing on lower cost programs first; implementing programs that provide ancillary benefits and/or lead to avoided costs; coordinating efforts based on state and federal programs.
- Faulty decision making and the incorrect or inadequate commitment of resources is a key concern.
- Based on uncertainty, timing and scale of climate impacts adaptation implementation should be structured with flexibility and phasing, and should provide ancillary benefits.
- When assessing potential adaptation measures to implement officials are looking at installation costs, the life span of systems, and maintenance costs over time. Avoided damage costs and assessing the costs of not acting are looked at but to a lesser degree.

RETREAT-

- At this point, retreat is not a critical issue for communities although discussions and studies are occurring.
- Retreat is looked at as a last resort versus the short-term focus on defense.
- As part of retreat related actions officials are looking at increasing development densities, better utilization of upland areas and buy-outs to enhance marsh migration.
- The issue is one of deciding to implement, including paying for, adaptation measures so people can stay where they are versus the costs-benefits of pursuing retreat and buy-outs later on.
- Officials wonder if retreat is a separate track that gets addressed simultaneously with other adaption efforts.
- How is retreat addressed in built out communities that have no higher elevation buildable land?
- Respondents asked how local government can pay for retreat especially if flooding has reduced tax revenue.

RECOMMENDATIONS-

The findings and information gathered in this report identified numerous recommendations I would suggest pursuing to help advance the implementation of adaptation measures to address coastal related flooding. Some of the more critical next steps include:

FINANCING-

- Develop information transfer programs for regional-local officials to expand the understanding and use of diverse funding mechanisms for adaptation.
- Encourage increased interaction between local and state officials and commercial funding organizations to encourage the development of adaptation funding sources.

GOVERNANCE-

- Expand the use of capital planning and municipal budgeting to address infrastructure projects. This can ensure the delivery of essential services, highlight adaptation progress and provide ancillary community benefits.
- Utilize Hazard Mitigation and emergency management plans to prioritize implementation projects. Potential projects should be assessed based on system component life spans vs. flood projections and ancillary community gains including social equity benefits.
- Use vulnerability assessments to guide comprehensive planning and zoning upgrades which can help shape long-term development and provide options for retreat and relocation activities.
- Increase municipal governance adaptation capacity through improved collaboration among departments, and for smaller communities, the use of NGO and regional planning commission resources to assist with planning, grant soliciation and project management.

DESIGN AND PERMITTING-

- Utilizing combined federal-state-regional-local-private sector efforts assess and address bottlenecks impacting the design and permitting of projects.
- Resolve conflicting requirements between agencies in order to streamline time frames, potentially reduce costs, and allow outside the box project options.

COORDINATION CONCERNS-

- Advance community support and stakeholder buy in for adaptation via the use of current, local focused flooding data, economic impact and benefit cost data, and stories and videos from diverse segments of the community.
- Determine ways for communities to engage in planning, permitting and funding for regional focused projects that can provide broader benefits and increased cost effectiveness.

MODELING & COST ANALYSIS-

- Conduct cost-benefit analyses and modeling for proposed adaptation measures including information on avoided costs and estimated social-economic-environmental benefits.
- Determine the types of modeling and cost-benefit analysis programs that would be the most beneficial to assist with municipal project decision making and assist commuities in using those tools. Such tools would be useful to identify impacts to infrastructure under various flooding scenarios, to determine avoided costs with adaptation measures, and to identify ancilary social-economic benefits from adaptation projects.

DECISION MAKING-

- Assist local officials with tools for decision making that address: short and long-term and/or phased approaches to adaptation implementation; cost-benefit analyses; the determination of primary and ancillary benefits; resolving social equity concerns; risk level assessment; climate impact uncertainty; climate change impact time frames.

RETREAT-

- Explore regional approaches for retreat in areas where communities have little or no land or suitable land for relocation.
- Via comprehensive planning increase development densities and encourage development in upland areas.

- Retreat research should include efforts to determine how built out communities can address relocation within their boundaries.

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APPENDIX-

FLOODING RELATED CLIMATE ADAPTATION IMPLEMENTATION SURVEY

The 26-question survey with responses:

Q1. What are the key things local officials need or want to know in order to implement flooding related adaptation programs (FRAP)? NOTE- "FRAP" is used throughout the survey and denotes Flooding Related Adaptation Programs.			
Responses	**Responses**	**%**	**Percentage of total respondents**
Stakeholder buy-in	20	68.97%	
Flood projection data	19	65.52%	
Economic information covering the impacts of flooding damage over time (including historical and potential future events)	20	68.97%	
Economic information from cost-benefit analyses on possible ancillary benefits, avoided costs and return on investment for measures being considered	22	75.86%	
A track record of previous steps and accomplishments	5	17.24%	
Funding options identified	26	89.66%	
(Did not answer)	0	0%	
Total Responses	**112**		20% 40% 60% 80% 100%
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q2. Note where flooding related adaptation program (FRAP) measures and programs are being developed within the following existing municipal planning and operations structures.			
Responses	**Responses**	**%**	**Percentage of total respondents**
Hazard Mitigation- Municipal Vulnerability Planning- Emergency Management	27	93.10%	
Comprehensive long-range land use planning and/or sustainability planning	24	82.76%	
Building codes	8	27.59%	
Zoning ordinances	11	37.93%	
Storm water and Waste water infrastructure	21	72.41%	

Capital planning	18	62.07%	
Municipal budgeting for operations and maintenance	11	37.93%	
Sectoral plans (spatial development; transportation; housing; economic development)	8	27.59%	
Other	3	10.34%	
(Did not answer)	0	0%	
Total Responses	**131**		20% 40% 60% 80% 100%
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q3. The following can be impediments or catalysts for implementing FRAP. First, note those topics that have been or are catalysts:			
Responses	**Responses**	**%**	**Percentage of total respondents**
Funding	21	72.41%	
Technical resources	16	55.17%	
History of flooding & disaster recovery efforts	20	68.97%	
Political will	18	62.07%	
Community buy-in	15	51.72%	
Useful flood projection information	11	37.93%	
Economic analyses	8	27.59%	
Governance structure	4	13.79%	
Legal issues	8	27.59%	
Comprehensive planning efforts	12	41.38%	
Social-economic-cultural issues	3	10.34%	
Disruption of essential services	15	51.72%	
(Did not answer)	0	0%	
Total Responses	**151**		20% 40% 60% 80% 100%
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q4. Using the same topics list, note which have been or are impediments or barriers for implementing FRAP.			
Responses	**Responses**	**%**	**Percentage of total respondents**
Funding	29	100.00%	
Technical resources	14	48.28%	
History of flooding & disaster recovery efforts	1	3.45%	
Political will	18	62.07%	
Community buy-in	14	48.28%	
Useful flood projection information	5	17.24%	

Economic analyses	7	24.14%	
Governance structure	11	37.93%	
Legal issues	12	41.38%	
Comprehensive planning efforts	2	6.90%	
Social-economic-cultural issues	7	24.14%	
Disruption of essential services	1	3.45%	
(Did not answer)	0	0%	
Total Responses	**121**		20% 40% 60% 80% 100%
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q5: What are criteria used to evaluate flooding related adaptation projects?

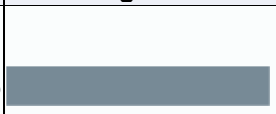
Funding	Cost effectiveness	Option costs & life spans	In MVP Plan & vulnerability ass.	Criticality of assets
Historic flooding	Impact on essential services	Infrastructure age	Cost-benefit assessment	Modeling for future events for flood risk
Preserve tax base	State-Federal grants	Level of protection from doing work; buy time	Permitting	Maintenance requirements
Stakeholder buy in	Integration with planning efforts	**(additional written answers collected)**		

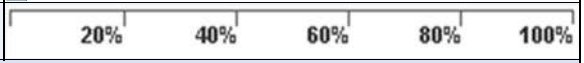
Q6. How do issues relating to climate change impact uncertainty (extent-timing-distribution), evolving climate change projections, and impact time frames guide decision making and implementation efforts to address coastal flooding impacts? (check all that apply)

Responses	**Responses**	**%**	**Percentage of total respondents**
Implement programs with short-term returns and benefits	12	41.38%	
Initiate lower cost programs first	10	34.48%	
Use planning-zoning-building code-hazard mitigation regulatory tools for gains over time	10	34.48%	
Coordinate efforts with state-regional-federal programs	18	62.07%	
Implement programs that provide ancillary benefits and/or avoided costs	18	62.07%	
Other (Please specify)	8	27.59%	
(Did not answer)	2	6.90%	
Total Responses	**78**		20% 40% 60% 80% 100%
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

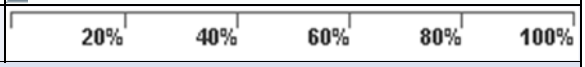
Q7. Various frameworks and modeling systems exist to assist with flooding related adaptation planning and implementation. Note which of the following you have utilized.			
Responses	**Responses**	**%**	**Percentage of total respondents**
Iterative risk management	5	17.24%	
Economic cost-benefit analysis including return on investments, life spans, ancillary benefits	15	51.72%	
Monetization assessments	4	13.79%	
Community Based Adaptation	14	48.28%	
Robust Decision Making	7	24.14%	
Integrated Coastal Zone Management	12	41.38%	
Adaptive Management	11	37.93%	
Disaster Risk Reduction	13	44.83%	
Other (Please specify)	3	10.34%	
(Did not answer)	3	10.34%	
Total Responses	**87**		20% 40% 60% 80% 100%
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q8. Rank the following for their importance in implementing FRAP initiatives:							
Answer	**Rank 1**	**Rank 2**	**Rank 3**	**Rank 4**	**Rank 5**	**Rank 6**	**Weighted Rank (Score)**
Uncertainty about climate change time frames means that FRAP related policies and programs should have flexibility and phasing aspects built into them	12	6	4	3	0	3	1 (130)
Along with addressing flooding, strategies should provide ancillary benefits to the community	5	10	4	4	4	1	2 (117)
It's important that efforts don't require extensive human vigilance or excessive annual maintenance	5	0	9	7	3	4	3 (97)
Incorrect or inadequate commitment of resources due to uncertain or wrong projections or faulty decision making is a key concern	4	6	3	5	5	5	4 (96)
Political value is a goal along with addressing flooding	1	3	7	4	4	9	5 (78)
Prudent risks should be taken	1	3	1	5	12	6	6 (70)
Did Not Answer							1
Total Responses							**29**

Q9. Which categories of adaptation measures have been implemented to address coastal flooding impacts?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Defend- minimize wave action; reduce erosion; protect against storm surges with soft or hard armoring; install grey and/or green infrastructure	25	86.21%	
Accommodate- make space for floodwaters by elevating infrastructure and buildings; install pump stations; construct channels	18	62.07%	
Retreat- transition utilized land to open space; abandon chronic inundation zones; construct living shorelines	9	31.03%	
(Did not answer)	1	3.45%	
Total Responses	**53**		
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q10. How has adaptation planning for FRAP been mainstreamed into established functions of local government operations?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Across sectors coordinated by a dedicated team with community wide adaptation strategies	12	41.38%	
Planning and action proceed in a limited and isolated fashion	16	55.17%	
No internal responsibility assigned for planning and implementation with a reliance on external resources	7	24.14%	
Other (Please specify)	4	13.79%	
(Did not answer)	1	3.45%	
Total Responses	**40**		
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q11. If adaptation and implementation efforts have been integrated into municipal governance has this led to more successful efforts over shorter time frames?			
Responses	**Responses**	**%**	**Percentage of total respondents**
More successful efforts	18	62.07%	
Shorter time frames	5	17.24%	
(Did not answer)	10	34.48%	
Total Responses	**33**		
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q12. Is there a correlation between greater community support levels and the ability to implement FRAP programs and policies?			
Responses	**Responses**	**%**	**Percentage of total respondents**
More support equals greater progress	24	82.76%	
Support is helpful for initial actions but not critical for ongoing efforts	6	20.69%	
(Did not answer)	1	3.45%	
Total Responses	**31**		
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q13. Elaborate on your answers for Question 12.

More action with more community support	Elected officials respond to the community needs and town meeting votes the spending - broad public support for funding is important in order to move projects forward.	Getting the public and Town departments to support a project is key to its success. Funding is doled out by the public.	The community is involved especially if it affects their property. Many residents are very supportive of adaptation measures as they have seen the effects of coastal storms and flooding first hand and have witnessed the increase in frequency and intensity over the years.	There needs to be support from key stakeholders through all phases of project implementation (design, permitting, construction)
More stakeholders that are engaged the more they take ownership of mitigation measures	General community support is important, but much more important are the officials and stakeholders and decision-makers in terms of making FRAP a priority and funding and implementing projects.	**(additional written answers collected)**		

Q14. Which flooding related issues have served as an incentive for FRAP adaptation planning and implementation?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Chronic inundation from tidal flooding	19	65.52%	
Significant storm events	27	93.10%	
Coastal erosion	20	68.97%	
Damaged-destroyed infrastructure (roads, bridges, water-sewer, schools, other municipal facilities)	18	62.07%	
Loss of tax revenue and loss of value to damaged-destroyed commercial and residential properties	7	24.14%	
Inability to deliver essential services	13	44.83%	
Social-economic-cultural impacts to the community	8	27.59%	
(Did not answer)	1	3.45%	
Total Responses	**113**		20% 40% 60% 80% 100%
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q15. Are flooding related adaptation policies-programs-investments assisted or hindered by state or federal level actions/regulations/mandates? Explain:

Guidance, technical assistance, and funding support from federal and state entities assists local adaptation efforts, but only if there is adequate support and technical assistance to pursue, receive, and utilize funding	Assisted by certain state programs and staff. Hindered by lack of cohesive state policies and frameworks	Federal and state regulatory policies can hinder implementation - there needs to be a better alignment of regulatory policy and mitigation efforts. There is not enough coordination with local government with the state so outreach and facilitation of coordinated efforts between a variety of agencies such as regulatory, roadway, bridge, utility (power, water, stormwater, i.e.) is needed to implement	Grant funding is essential and assists. Regulations sometimes get in the way of innovative approaches.	The permitting process is complicated, expensive, and lengthy

		effective spending of the limited resources.		
Hindered. Out of date regulations do not allow for novel mitigation activities or or pilot projects or research to test out of the box techniques.	Permitting and people's wants often conflict.	State and federal level actions have both helped and hindered. Programs like the state's Municipal Vulnerability Preparedness program have helped focus attention and resources. Multiple, overlapping, and sometimes incompatible regulatory requirements for anything along the shoreline, however, has definitely driven up costs and extended the amount of time for taking action.	**(additional written answers collected)**	

Q16. If applicable explain where there is coordination and collaboration among communities on the implementation of flooding related adaptation initiatives:

Portland and South Portland, Maine: Working together on an initiative called "One Climate Future."	Regional planning organizations and regional economic development organizations have provided assistance, capacity, and leadership in some parts of the state.	We have been able to coordinate on infrastructure - bridges, sea walls and emergency response, and planning, outfall improvements. We are now working with abutting communities on sea level rise and wave impacts, flooding for our local bays.	CRMC (the state CZM agency) has many initiatives for identifying potential FRAP and working with communities for funding and construction of coastal resilience green infrastructure projects. Currently we are developing an inventory of potential projects and funding the design for several projects.	New Bedford and Fairhaven collaborated on an MVP grant to evaluate shared harbor vulnerabilities. This partnership is expected to continue.

Shared waterways, streamlining regulations and procedures.	County-level emergency response planning, seacoast transportation corridor project	Working with the Rockingham Planning Commission on a variety of multi-town initiatives in Seacoast NH.	Coordination at the marsh scale in which restoration and resiliency benefits large segments of the coastline	**(additional written answers collected)**

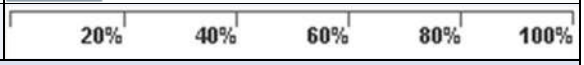
Q17. If nuisance and inundation flooding is increasing, what are some of the impacts being experienced and how are response steps being prioritized?

Road overtopping, leading to culvert replacements, which are prioritized and added to CIP if public safety, disruption to services, and other impacts are experienced.	Local and state roadways experiencing tidal flooding more frequently, low-lying coastal neighborhoods experiencing more frequent flooding, culverts at tidal crossings are insufficiently sized, less beach area for residents and tourists.	Impacts: street closures; private property flooding; erosion of coastal features and loss of ecosystem services; degradation or loss of function/use of infrastructure or other community assets (e.g. waste/storm water facilities, parking lots, wharves, etc.)	Blocking off parking; placing road barriers up	A few roads are closed off to traffic if there is alternative access to properties. Road ends that are eroding have been redesigned for stormwater LID and public access, many marsh elevation, restoration and creation projects have been completed. A Coastal Hazard application has been developed so that any new or substantially improved coastal projects must consider how sea level rise, storm surge and coastal erosion will impact the project.
Certain people cannot park on their streets during high tides, and their homes are getting flooded. They are looking to the town and state for assistance and ideas on what to do. The town is doing a thorough flooding analysis.	Roadway and pump station flooding. Impacts to essential services are priority - evaluate impacts and develop short term and long-term responses and funding plans	Reverse flow in the stormwater systems is becoming an increasing problem, with tidal flow traveling inland and creating sunny day street flooding. We are going to try to mitigate with tide gates. In general, the goal is to	Visible erosion of shoreline near critical infrastructure has led to more prioritization of response steps.	**(additional written answers collected)**

		maintain transportation corridors during extreme high tides.		

Q18. Identify which funding sources are used for FRAP implementation programs?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Municipal operations and maintenance budgets	20	68.97%	
Capital planning programs	21	72.41%	
FEMA Flood Mitigation Assistance Program	13	44.83%	
FEMA Pre-Disaster Mitigation Program	17	58.62%	
National Flood Insurance Program	8	27.59%	
FEMA Hazard Mitigation Grant Program	21	72.41%	
HUD CDBG Disaster Recovery Program	7	24.14%	
Small Business Administration Disaster Loans	3	10.34%	
Federal Highway Administration Emergency Relief Program	6	20.69%	
USDA Natural Resource Conservation Service Emergency Watershed Protection Program- Floodplain Easement Program	3	10.34%	
State Resilience Grant Programs	20	68.97%	
NOAA Sea Grant- Coastal Resilience	12	41.38%	
Bonds (Revenue, Green, TIF)	9	31.03%	

Q19. Which of the following tools and resources are used for flooding related adaptation planning and implementation?			
Responses	**Responses**	**%**	**Percentage of total respondents**
U.S. Global Change Research Program- National Climate Assessments	3	10.34%	
NOAA- U.S. Climate Resilience Toolkit: Sea Level Rise and Coastal Land Use	14	48.28%	
NOAA- Adaptation Clearinghouse	5	17.24%	
NOAA- Office for Coastal Management: Digital Coast	9	31.03%	
Climate Central- Surging Seas	2	6.90%	
Georgetown Climate Center- Adaptation Clearinghouse	5	17.24%	

First Street Foundation- National Flood Model	4	13.79%	
Cape Cod Commission- Coastal Planner	3	10.34%	
Jupiter Intelligence- Modeling for Climate Change Risk	0	0%	
NOAA- Sea, Lake and Overland Surges from Hurricanes (SLOSH) Model	10	34.48%	
ADCIRC- Model for Predicting Storm Surges and Tides	4	13.79%	
USGS- Coastal Storm Modeling System (CoSMoS)	4	13.79%	
FEMA- HAZUS Mitigation Planning	14	48.28%	
Other (Please specify)	12	41.38%	
(Did not answer)	5	17.24%	
Total Responses	**94**		
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q20. Which of the following are assessed concerning community infrastructure and FRAP efforts?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Installation costs	24	82.76%	
Maintenance costs over time	20	68.97%	
Life span of systems	21	72.41%	
Avoided damage costs	13	44.83%	
Ancillary benefits	13	44.83%	
Costs of doing nothing	14	48.28%	
Other (Please specify)	4	13.79%	
(Did not answer)	1	3.45%	
Total Responses	**110**		
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q21. Is retreat an adaptation measure that is being studied or that has been implemented to address flooding impacts?

Not yet, preliminary discussions occurring	Not very much as yet. Our trying to get an alternative transportation route more inland is a form of retreat. However, the State Highway is not going away. It cannot be elevated since it is densely populated with important businesses on both sides.	Retreat projects have been done for infrastructure more than houses.	We always keep retreat in mind, though I imagine it would be a last resort. Phase retreat could be more palatable to the public if needed.	Yes, including the development of coastal buyout or flood recovery and relief programs and salt marsh migration pathway land acquisition
It has been talked about but not embraced by municipalities (yet) as our property tax dollars make up our municipal budgets	Relocation of critical utility infrastructure away from inundation areas is considered	No. Too politically charged at the local level	Retreat has been identified as an inevitable step to be studied during the coming years, but the present focus has been on defense.	**(additional written answers collected)**

Q22a. If retreat related measures have been implemented how long has retreat been used?

Early 1980s	Two years	For properties impacted by 2010 flooding	2008	

Q22b. If retreat related measures have been implemented how many properties have been purchased?

70+	1	Unknown	1	

Q22c. If retreat related measures have been implemented where do buyout fees come from?

ACOE/FEMA/grants	Community Preservation funds and Town meeting	NRCS and FEMA mitigation funds	100% FEMA	

Q23. As part of retreat what regulatory changes were made to prevent future development in flood prone areas?

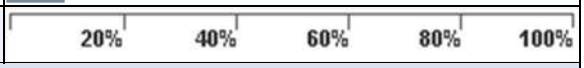
Conservation Restriction placed on land purchased	Flood hazard overlay district encourages building to higher standards in the projected floodplain in addition to requirements in the current mapped floodplain	Conservation / floodplain easements	Looking at model floodplain bylaw with neighboring towns through grant from Cape Cod Commission, our regional county planning agency	Zoning will only address future growth sadly the entire coast line is already developed originally as summer cottages on 5,000 sq.ft. lots.
The entire property is covered under the Wetlands Protection Act therefore no building will be added to the property that is not in existence already	Building Code-doesn't prevent. Only way to "prevent" is to purchase fee simple or development rights.	Future retreat may require expansion/modification of Designated Port Areas.		

Q24. Following retreat initiatives how has the vacated land been utilized?

Retreat was limited to relocation within the property boundaries so the land remained in private ownership unless it had eroded away.	Parks or return to natural buffer function	Conservation land	Where private buildings have been lost to storm damage, new buildings have replaced them in some cases along the coast.	Returned to coastal dune/beach
Left as an open lot				

Q25. Which of the following factors would make retreat difficult to implement?			
Responses	**Responses**	**%**	**Percentage of total respondents**
Economic gains from coastal development	16	55.17%	
Subsidized insurance rates	12	41.38%	
Disaster recovery funds	7	24.14%	
Diverse risk perceptions	13	44.83%	

Attachment to place/cultural-economic ties	19	65.52%	
Preference for the status quo	15	51.72%	
Other (Please specify)	4	13.79%	
(Did not answer)	5	17.24%	
Total Responses	**91**		
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

Q26. Is retreat looked at:			
Responses	**Responses**	**%**	**Percentage of total respondents**
As a measure of last resort?	9	31.03%	
A strategic and managed adaptation measure?	12	41.38%	
Other (Please specify)	8	27.59%	
(Did not answer)	3	10.34%	
Total Responses	**32**		
Because multiple answers per participant are possible, the total percentage may exceed 100%.			

ACKNOWLEDGEMENTS-

I would like to thank the many professionals who graciously took time to assist with this project by completing a survey and/or by chatting. Whether a town manager, NGO director, regional planning commission environmental program manager, state sustainability officer, state coastal resources coordinator, economic development agency staff, state environmental protection coordinator, public works director, town planner, municipal utility director, town conservation officer or academic institution resilience planner, this project allowed me to meet with a diverse and engaged group. All those who I spoke with or reviewed surveys from exhibited a deep commitment to helping communities increase resilience and address expanding climate change impacts.